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ABSTRACT

The evaluation of future needs for the K-12 science program in the Fresno City Unified School District used four goals for science education published in the Science Framework for California Public Schools. These goals are (1) to develop attitudes that underlie the personal involvement of the individual with his environment, (2) to develop a scientific mode of inquiry, (3) to develop fundamental skills for scientific inquiry, and (4) to develop the knowledge of a body of facts and concepts necessary for further interpretation of the natural world. The experimental design consisted of site visits to 73 schools at the elementary, junior high, and senior high levels. In the elementary and junior high schools, an understanding of these goals by teachers and administrators was highly recommended. The report suggested that the junior high program could be upgraded by providing more science experiences, although more laboratory equipment must be acquired. The senior high program should provide more introductory courses in the physical sciences that are relevant to the noncollege-bound student. A detailed matrix of educational needs for each grade level is contained in the report. The research was conducted as part of PROJECT DESIGN, funded under ESEA Title III. (LN)

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EDUCATIONAL NEEDS

13. SCIENCE

FRESNO, 1968

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FRESNO CITY UNIFIED SCHOOL DISTRICT

1968

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FOREWORD

PROJECT DESIGN (Inter-Agency Planning for Urban Educational Needs) was organized as a two-year project to develop a comprehensive long-range master plan of education for the Fresno City Unified School District in California.

This project was conceived by school leadership to bring under one umbrella current major problems of the schools, the relationship of the schools to the broader community, the impact of educational change now occurring throughout the nation, and a fresh view of the educational needs, goals and aspirations of our youth and adults. The ultimate purpose of the project is to weld into an integrated plan the best use of available resources to meet the totality of current and projected needs according to their rational priorities.

The United States Office of Education funded the proposal as an exemplary Title III project, recognizing the urgency for developing better planning processes for urban school systems. The first year of this project was organized to assess current and projected educational needs in the urban area served by the Fresno City Schools. Planning procedures will be carried out in the second project year.

A major dimension of the Needs Assessment is an analysis of educational and urban factors by a Task Force of specialists. This report is one of the Task Force Needs Assessment publication series. See the next page for the complete list of project Needs Assessment publications.

PROJECT DESIGN

NEEDS ASSESSMENT PUBLICATIONS

1. Brainstorm - Needs Perceived by School Staff
2. Speak-Up - Needs Perceived by Community
3. Student Speak-Up - Needs Perceived by Secondary Students
4. School Staffing
5. Analysis of Achievement
6. Problems Perceived by Educational Leadership

County Schools Survey

7. Vocational Occupational Needs Survey (published by County Regional Planning and Evaluation Center - EDICT)
8.
9. Other County School Needs Survey Reports (by EDICT)

TASK FORCE

Educational Content Fields

10. Reading
11. Language
12. Mathematics
13. Science
14. Foreign Language
15. Cultural Arts
16. Social Science
17. Physical Education

Other Educational Areas

18. Teaching/Learning Process
19. Special Education
20. Guidance
21. Health
22. Student Personnel
23. Adult Education
24. Vocational Education

Urban Physical Factors

25. Urban Physical Factors

Urban Social and Human Factors

26. Relevance and Quality of Education for Minorities
27. Special Needs of Mexican-Americans
28. Special Needs of Negroes

29. Conclusions from Needs Assessment Publications
30. Summary - Fresno Educational Needs Assessment
31. The Process of Educational Planning

13. SCIENCE

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INITIAL CHARGE

In making the assessment of the science education program the committee adopted the goals for science education from the (1) Science Framework for California Public Schools (preliminary publication 1968) in arriving at a matrix for making observation. (See Appendix for Matrix). This publication recognizes four major goals:

1. "Attitudes - to develop those values, aspirations, and attitudes which underlie the personal involvement of the individual with his environment and with mankind;
2. Scientific Mode of Inquiry - To develop the rational powers which underlie the scientific mode of inquiry;
3. Skills - To develop fundamental skills in manipulating materials and equipment and obtaining, organizing, and communicating scientific information; and
4. Knowledge - To develop the knowledge of systematic facts, concepts, and generalizations which lead to further interpretation and prediction of the natural world."

While the present science program in the Fresno Unified District was not designed specifically to meet these goals, the assessment team believed it desirable to use them as a reference point since they developed by the State Department of Education and should be followed in designing the science program for the future.

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(1) Science Framework for California Public Schools. California State Department of Education, Sacramento, 1968, pp. 15 - 19.

EXPERIMENTAL DESIGN

The assessment of the science education program K-12 of the Fresno Unified School District, under the direction of Project Design - Interagency Planning for Urban Education Needs, and financial by fund from Title III Elementary and Secondary Education Act, was conducted during May, 1968, by an evaluation team composed of Mr. George Katagiri, Oregon State Science Supervisor; Dr. John Harville, Professor of Biology, San Jose State College; and Dr. Stanley Williamson, Chairman, Department of Science Education, Oregon State University. The committee recognizes that the time available for this assessment was entirely too short to complete a detailed evaluation of a school district composed of 52 elementary schools, 14 junior high schools, and 7 senior high schools. However, with the excellent materials provided by Project Design personnel, classroom visitations, results of standardized tests used, and the excellent cooperation the committee received from school administrators and teachers, enabled the committee members to arrive at some general conclusions and to make specific recommendations for improvement of the program. The committee members have attempted to generalize on the basis of this limited contact in order that recommendations made may have some value, but with the full recognition that sampling was far too limited to have true validity for the system as a whole.

The following factors limited observations and conclusions:

1. Limited time available for classroom visitations. (2 - 4 days) Each day each member of the committee visited 6- 8 classrooms in 3 - 5 schools. Selection of schools to be visited was made by administrators of Project Design, and with in-school visitation schedules set up by the building Administration. (Mr. Katagiri spent 4 days visiting elementary schools; Dr. Harville and Dr. Williamson 2 days visiting junior and senior high schools. In all cases, opportunities were provided for discussions with teachers and administrators outside of class.

2. Visitations were too late in the school year (May) for optimal observations. In some instances classes were engaged in summarizing testing, and other end of school activities not typical of the school year as a whole.

3. Some administrators, and teachers were not entirely clear as to the objectives of Project Design; thus preparations were less than optimum.

4. A conference set up for Saturday morning, May 25, with the Science Coordinator and members of the Science Curriculum Committee produced so small a turn-out that the discussion during the meeting was not representative of the broad spectrum of science areas (elementary, junior high school, and senior high school) and interests necessary for a real interchange of ideas or airing of problems.

Working within these limitations the assessment committee believes that **observations** made and reported in this study, while they must be viewed as tentative, do represent observable trends in the science education program in the Fresno District, and the recommendations viewed as indicative of suggested directions rather than definite opinion.

A Philosophical Basis for Assessment

It is appropriate to include a philosophical statement at this time. The definition and purpose of an elementary science program which reflects the intent of the Science Framework for California Public Schools should be clarified if the instructional needs in this report are to be clearly understood.

There is considerable discrepency between the accepted goals of science education and classroom practice. Within the past ten years, a national effort has been made to alleviate the existing situation. This effort has resulted in a number of curriculum projects which have produced materials which achieve more desirable goals and which emphasize behavioral outcomes in science instruction. For many years one of the general goals of science education has been to develop in the individual an understanding of his natural environment. More specifically, the learner, hopefully, would understand the natural **phenonena** associated with many aspects of his environment, such as weather, nuclear energy, heat, etc. With these understandings he would, hopefully, be able to interact to many aspects of his physical world with confidence or with a minimum of fear.

In recent years an additional consideration has been identified with science education. The knowledge explosion which is documented by the 300,000 research studies conducted last year and the influence of this new knowledge on the technology and on the life of each citizen is causing changes to take place in society at an exponential rate. To limit the goal of science education to the accumulation of knowledge is inadequate in view of the rapid changes taking place. If we are to maintain a literate and free society, it is necessary that members of the citizenry acquire skills which enable them to learn for themselves throughout adulthood. In addition to the accumulation of knowledge, science programs need to make a concerted effort to develop in students acceptable attitudes, self-learning skills, and a mode of inquiry. These goals are highly desirable for all members of our society regardless of their ethnic group or socio-economic status.

It should be emphasized also that almost 100 percent of the children in Fresno attend the first seven years (K-6) of school. Most of these children will not take more than one or two years of science beyond the sixth grade. Under these circumstances the major responsibility to attain the goals of science education is in the hands of elementary school personnel. An effective elementary science program is essential.

MAJOR CONCLUSIONS

After careful study and analysis of the materials provided, the assessment team by Project Design (Extensive data regarding the community, schools, problem identification, ~~etc.),~~ classroom visitations, conferences with teachers and administrators, and limited contact with members of the science committee, the following conclusions can be drawn and recommendations made:

A. Conclusions on Elementary School Program.

On the basis of this assessment, a number of needs for the elementary science program have been identified. there are other needs of a more general nature which could be emphasized in this concluding section.

There was considerable evidence which indicated that teachers and administrators of the elementary schools were not aware of the goals for a modern science program. The limited view that science is an organized body of knowledge or that science is a second rate subject is inadequate for Fresno children. The idea that we must educate children to the knowledge known to date is also inadequate. The world as we know it today will be quite different by the time elementary children are in the productive years of their lives. Children in elementary schools today need to develop efficient methods of self-learning. Additionally, science literacy is not reserved for the scientist, who works in a special place with special equipment. The elementary school is educating children who will determine whether or not society will maintain an environment which is fit for man to inhabit. They need to be prepared to make decisions on problems concerning air and water pollution, the use of insecticides, population control, the use of nuclear energy, the extent to which a science program is supported in the public schools, etc. They need to understand the role which science and its mode of inquiry play in daily living. They need to know how to remain literate after they leave school. These ideas about science education need to be understood by all staff members.

The goals used in this assessment would tend to achieve these ends. All staff members need to understand these newer goals of science instruction. One effective procedure and a highly recommended program would be to appoint science coordinators in each building to develop curriculum committees to establish a developmental science program which would meet the needs of its students and approach the desired goals of science education. To follow the structure of the textbook is not necessarily recommended. Also, it is not necessary to develop a highly structured scope and sequence.

The Science Framework for California Public Schools has developed adequate guidelines for committees to follow. This document along with consultant services should help to develop an effective program. Additionally, it would be highly desirable for any curriculum committee to examine the materials which have been developed by national curriculum projects in recent years. The financial and human resources which have gone into the development of these materials are worthy of consideration by committees which plan to implement new curricula. Among others, the materials from Science-A Process Approach, the Elementary Science Study, and the Science Curriculum Improvement Study are appropriate for consideration.

In its final form, the elementary science curriculum should reflect the dynamic nature of change which exists throughout society. It should incorporate a feedback system which affects gradual and continual change. The leadership throughout the school system should create an atmosphere where rational improvement is encouraged and where it can take place readily.

B. Conclusions Junior High School Science Programs

The science program in the various junior high schools is too limited in scope and does not meet the needs of a large segment of the students. The program should be extended to provide science experiences at each grade level (7-9) and for the variety of individual differences found in the community. The one year of required science in the junior high school covering all areas of science and/or topics required by the state, makes for a limited program that is not suitable in a modern technological society. Administrators and teachers are urged to study and evaluate the new curriculum projects for possible inclusion in the Fresno program (i.e. Florida State Program, Earth Science, Princeton Project, etc.)

The junior high school science program is not laboratory oriented in many of the schools. This may be due to lack of preparation on the part of the teachers, of materials and equipment, of adequate classroom facilities, and/or the necessary teacher time to develop laboratory experiences. There is limited opportunity for students to investigate, or discover for themselves some of the important concepts in science or to become familiar with the processes of science. There is considerable evidence that major emphasis is placed on the products of science and/or the mastery of subject-matter rather than the more permanent learning resulting from process-laboratory centered science.

There is need for wider selection and use of supplementary teaching materials (books, films, etc.) and more extensive use be made of the many materials housed in the Resource Center housed in the Administrative complex. Science teachers have heavy teaching loads and could possibly make better use of supplementary materials had they more time to plan. This problem might be solved by increasing teaching staff or by adding paraprofessionals (laboratory assistants, interns, etc.) to the staff. The need for supplementary materials was particularly apparent in the compensatory schools, as was need for special techniques and methodology in working with culturally disadvantaged students.

C. Conclusions Senior High School Science Programs

In general, in the newer high schools facilities for teaching science are excellent, and in sharp contrast to conditions found in older high schools in certain sections of the city. Materials and equipment would equal or exceed minimal requirements to meet the needs of the modern high school curriculum. With few exceptions classrooms were crowded and too small for the class size assigned, especially when teachers were using the laboratory-centered programs.

The imbalance in science offerings and enrollments in the biological and physical sciences is quite apparent. Enrollments in the physical sciences are considerably below national averages and should be of concern to administrators, teachers and the community. This is possibly due to heavy emphasis on the college bound student, new curriculum programs, and the fact that science in the 11-12 grades are directed to the high ability level student. A need does exist for the kind of physical science that has practical value and helps the student better understand his physical environment. Only five schools offer a course in Introductory Physical Science with a total of only eight classes. This condition is both unrealistic and must be considered unsatisfactory. The entire physical science program should be studied by a city-wide committee who should be responsible for making recommendations for correcting conditions that exist.

In general, teachers are dedicated, interested and enthusiastic about their teaching assignments. Each is carrying a heavy teaching load, which leaves little time for the planning that is necessary to carry out a complete science program.

Observations and Discussion of Practices in the Elementary Science Program of the Fresno Public Schools

The matrix used to assess the elementary school science program included goals which were based on the foregoing philosophical premise. In the visitations to schools, there was little evidence that students were attaining the majority of goals specified on the matrix. From conversations with teachers and students, it was evident that most of the effort in science instruction was for the child to accumulate some knowledge about a particular phenomenon.

In each school the science program for each class was essentially the responsibility of the classroom teacher. In no instance did a school have a K-6 developmental science program or a science curriculum committee in operation. The state adopted textbook formed some basis for a program in some classrooms. With regard to the state adopted textbook, 14 out of 19 indicated that they did not use the textbook for instruction. Three of these were kindergarten teachers. Five teachers indicated that they covered from two-thirds to three-fourths of the text. This information is intended to point out the lack of a developmental program and is not intended to make a value judgment on the use of a textbook. In practice, it was evident that some of the better programs, as judged by the likelihood of achieving goads, were insituations where the textbook was not used. In the majority of classrooms the time spent on reading about science or in engaging in activities in science was minimal or lacking. In most instances, it was clearly evident that where science instruction existed, it was primarily a reading activity..

There was an almost unanimous complaint from teachers that the reading level of the textbook for any given grade was too difficult for a large portion of the children. One teacher felt that the reading level of the textbook for any grade was satisfactory but that it was necessary to "read the chapter together as a class."

When teachers were asked what was their goal in teaching science, the most common response was "to arouse interest" in the world around them. There was ample evidence in two kindergarten classes and one fifth grade classroom that curiosity in children was being generated. Several of the operational objectives under Goal I were being developed in young children. However, in the remaining grades there was more evidence to indicate that when science was taught, the actual outcome was for children to know about a particular science topic rather than to arouse their curiosity. This became evident when teachers explained that the class had learned about "space" or about "animals" and when children described what they did in science. At no time was there reference to developing a mode of inquiry, the development of skills, or forming attitudes associated with scientific endeavors.

The equipment and materials for science instruction depended primarily on the initiative of the teachers. One teacher had considerable glassware and materials for science, but this was an exception. Five of the eight schools had portable demonstration tables with a minimum of science equipment being stored in them for the entire school. In one school one table was shared by over 700 pupils. In other instances a science box containing a minimum of equipment was shared by the entire staff. In one instance there was one science box for every grade level or one for every three classrooms. It is evident that a school science program where children can use skills of investigation using laboratory equipment is not possible with such limited equipment and materials. Secondly, the portable tables, when used, were used primarily for demonstrations. Although demonstrations have a valid place in the curriculum, it is reasonable to assume that the accepted goals of a science program can be achieved better if children were involved as the principal investigator rather than as a passive observer. In examining the available equipment and from comments of administrators, the existing equipment was not being used extensively by teachers who had them. Also, few teachers bothered to use the equipment when they were stored in another room. There was evidence that equipment and materials such as science films, micro-projectors, planetaria, and other items from the instructional materials center were being used by several teachers. The center was providing a valuable service for these teachers. In one instance a teacher could not operate a micro-projector after she had received it from the center. There is need for a workshop where teachers can learn to operate some of the available equipment housed at the center.

The library resources at six schools were observed. The number of science books ranged from over 100 volumes to well over 200 volumes. Most were books for the primary grades. In general, the number seemed adequate. However, the effectiveness of library resources is measured partly by their use. A superficial examination of the check-out slips indicated that the science books at Calwa Elementary School were being used quite extensively. Other libraries did not reflect similar usage. In fact, several library clerks stated that teachers seldom used the library in connection with instructional activities. They library program is expecially significant in science education since one of the most important sources for up-to-date information after children leave school is the public library. If children are to understand the role of the library in adult living, its use should be an integral part of the instructional program.

One of the basic prerequisites for understanding one's environment is the ability to observe accurately. Research indicates that young children can be trained to observe and to distinguish between observations and inferences with little effort. They can also be trained to become skilled in making quantitative observations and in describing observations where changes take place. However, competence in observing requires training. In discussions with children in eleven classrooms, it was observed that there was very little development of observation skills. Sixth grade children were observing at the same level of competence as primary children. Only a few children could make quantitative observations and many could not distinguish between an observation and an inference. There was some evidence that some third and fourth grade children could classify a group of objects according to similarities and differences. These kinds of skills or processes are prerequisites for efficient self-learning to take place.

Effort to develop a program in this direction is particularly significant to the Fresno Public Schools since an activity-centered program which develops these kinds of competencies does not discriminate against children who tend to be less verbal or who are regarded as culturally deprived.

If the elementary science program in the Fresno schools is assessed on the basis of the goals accepted by the science committee of Task Force #1, it is evident that there is room for improvement. The genesis for such improvement is evidenced with the recent in-service programs in elementary science which were designed to develop a mode of scientific inquiry and skills for investigating. However, they have reached a very small proportion of the teaching staff. Similar programs need to be continued. A concerted effort is needed to eliminate the deficiencies in the present program and to approach the accepted goals for elementary science instruction.

To identify the needs of the elementary science program, summarized statements have been categorized on the following matrix:

CLASSIFICATION MATRIX OF NEEDS
ELEMENTARY

I. GOALS (Science Framework for California Public Schools)	II ASSESSMENT - OBSERVATION	III. STRENGTHS AND WEAKNESSES
1. VALUES, ASPIRATION, ATTITUDES for Personal Involvement A. Demonstrates curiosity B. Shows interest in theory-building with attention to discrepencies C. Seeks interaction with others D. Demonstrates Scientific integrity E. Identifies values of Beauty F. Relates science to other human endeavors	Curiosity was particularly evident in 2 kindergarten and one 5th grade classroom. In all cases, the environment included living things & objects which had relevance to children. In the majority of classrooms there was no particular evidence of any exceptional enthusiasm. The children in the lower grades tended to be more enthusiastic than those in the upper grades. Some classrooms were quite rigid in their discipline. There was no evidence that any classroom was involved in science investigations where values, aspirations, and attitudes associated with science could readily develop.	Those teachers who provide a rich classroom environment which is relevant to children also provide a learning situation which is conducive to develop desirable values, aspirations, and attitudes. Such teachers who provide this in science are in the minority. Few activities provide children with an opportunity to experience activities in life situations and with real objects where appreciations can develop. Where the achievement of these goals was evident, they existed at a very elementary level. A developmental program is needed. Opportunities on field trips to the coast or to the mountains were excellent. Two classes benefited by such programs. The development of this goal seemed to diminish with the advancement in school. It would be legitimate to raise the question: Does the school program have a negative effect on children in science?

ELEMENTARY

IV. INSTRUCTIONAL NEEDS	V. AUTHORITY, RESPONSIBILITY, INFORMATIONAL NEEDS	VI. DIRECTIONAL PLANT AND EQUIPMENT NEEDS
1. Children should be involved in activities where they can experience values such as idea sharing, intellectual honesty in presenting data, humaneness, etc. in real situations. These values should not be taught verbally but should become meaningful because they work in practice. The learning environment should include a number of living things (plant and animal) which can be examined on a first hand basis. Such items arouse much curiosity. Instruction in science should have relevance to the learner. The study of extensive units on topics such as "molecules" or "chemical' reactions" for young children can be questioned. Relevance fosters interest. Extension of instruction beyond the four walls of the conventional classroom for some subjects can make learning meaningful. Some things can best be learned outside the classroom, for example, field trips to natural settings or to industries. Upper grade children need opportunities to collect data and to form conclusions based on the data to develop faith in his rationality.	1. A need for leadership to provide a seminar or study group on educational objectives in the affective domain. Facilitate the pick-up and delivery of items, such as, small animals, from the zoo or museum. Arrange for field trips which are designed to fulfill specific objectives. Provide leadership in the area of K-6 curriculum development in science. Facilitate the arrangement of greater mobility and flexibility in learning stations.	1. Provide resource units and equipment which tend to foster objectives in the affective domain. Assist financially in providing transportation for field trips. Make available equipment for the care of living things. These include aquaria, terraria, cages, planting pots, etc. Provide guidelines for the district elementary science program. Provide additional consultant services.

ELEMENTARY

VII. COORDINATIVE - SUPPORTIVE NEEDS	VIII. SOLUTIONS AND RECOMMENDATIONS (IF ANY)
1. Develop parent education programs. Coordinate activities with the museum, the zoo, and local pet stores in obtaining living animals for classroom care and observation. Coordinate programs with local industry and community service agencies to identify learning stations away from school where understandings about the environment can be learned more effectively.	1. Appoint building science coordinators who are responsible for curriculum development in elementary science.

CLASSIFICATION MATRIX OF NEEDS
ELEMENTARY

I. GOALS	II. ASSESSMENT OBSERVATION	III. STRENGTHS AND WEAKNESSES
2. SCIENTIFIC MODE OF INQUIRY A. Identifies problems B. Formulates hypotheses C. Generates data D. Draws inferences E. Predicts events F. Generalizes	2. There was no evidence that the science program was systematically developing a scientific mode of inquiry. Two classes used material which were designed to develop processes of science but in both cases the effort was limited to two lessons during the year. Involvement by children in science appeared to be primarily verbal and passive.	2. The extent of involvement by children in science activities was primarily limited to "show and tell," verification by demonstration, or library reports. Some of these were dramatic and each has its place but they do not seem to develop a scientific mode of inquiry in each child.

ELEMENTARY

IV. INSTRUCTIONAL NEEDS	V. AUTHORITY, RESPONSIBILITY, INFORMATIONAL NEEDS	VI. DIRECTIONAL PLANT AND EQUIPMENT NEEDS
2. Design instruction to develop competence in processes, such as, observing, inferring, classifying, using numbers, experimenting, etc. Which are used in scientific inquiry. By the time children leave the sixth grade, they should be able to design an experiment which leads them to experience the behaviors listed under "scientific mode of inquiry" at the left.	2. Coordinate in-service programs and assist teachers with instructional as well as equipment problems. Assist in providing a classroom environment in which children can inquire into nature on a first hand basis.	2. Provide the proper units and necessary equipment and materials which will enable teachers to provide effective instruction. Provide teacher in-service which is designed to develop a degree of competence in scientific inquiry. Provide instruction which informs teachers of the level of competence expected in children at particular grade levels.

ELEMENTARY

VII. COORDINATIVE - SUPPORTIVE NEEDS	VIII. SOLUTIONS AND RECOMMENDATIONS (IF ANY)

CLASSIFICATION MATRIX OF NEEDS
ELEMENTARY

I. GOALS	II. ASSESSMENT OBSERVATION	III. STRENGTHS AND WEAKNESSES
3. SKILLS WITH EQUIPMENT, MATERIALS, & COMMUNICATION A. Constructs & uses laboratory apparatus B. Selects appropriate source materials C. Accurately records and organizes observations D. Communicates effectively with appropriate terms and symbols	Five of the eight schools had a portable science table with minimum science equipment. In most instances the table was located in a selected classroom. In addition, two schools had science kits which were shared among teachers. Two schools had little or no equipment available for teachers. A few teachers had accumulated items on their own. Others depended on the instructional materials center for supplies. Children in a few classes made science notebooks; they contained reading reports, observations, and some art work. There was no evidence of a science log which recorded data from experiments. A team of 3 teachers imitiated a science fair at one school. They reported that student projects were generally unimaginative and quite mechanical. However, the students learned a great deal about investigations. They plan to have more experimental projects next year with required logs.	In most instances, there was little evidence that equipment was being used to any extent. Teachers in whose room the equipment was stored indicated that few teachers came to borrow equipment. The description of activities by teachers... indicated that science activities were predomiatly demonstrations. A science program in which children can actively participate is not possible with the present level of equipment and materials. The type of initiative exhibited by the teachers who organized the science fair is to be commended. They exhibit the creative nature of science through which new insights are gained and programs are improved. Such activities, when developed properly, foster the development of self-learning skills.

ELEMENTARY

IV. INSTRUCTIONAL NEEDS	V. AUTHORITY, RESPONSIBILITY, INFORMATIONAL NEEDS	VI. DIRECTIONAL PLANT AND EQUIPMENT NEEDS
3. Provide instruction on when and how simple apparatus can be used to learn more about natural phenomena. Apparatus such as microscopes, balances, and other measuring devices should be included. Children need to discover logical ways in which data and observations can be recorded and communicated to others. They need to become proficient in using the metric system to measure length, area, volume, and mass. Intermediate grade children should be able to organize logs of their own design which clearly communicate a series of related science activities. Logs should include graphs and tables as well as narrative descriptions.	Provide adequate equipment and materials which are necessary to execute an activity centered program for all children. Be responsible for designing and providing an efficient storage and distribution system for equipment and materials within the building. It may be necessary to store some items in a central storage area. Provide a professional resource library for teachers. The center should include periodicals on elementary science and references regarding the use of science equipment and materials. It should also contain the materials which are available from the I.M.C.	Assist building principals in funding the acquisition of equipment and materials. Provide in-service training to acquaint teachers with the proper use and care of science apparatus. Assist teachers to use unfamiliar material, such as, chemicals, protozoa, cultures, etc. Encourage the use of services from the I.M.C. Coordinate classroom use of borrowed materials from the museum, zoo, industry, and other community agencies.

ELEMENTARY

VII. COORDINATIVE - SUPPORTIVE NEEDS	VIII. SOLUTIONS AND RECOMMENDATIONS (IF ANY)
3. Supply free and inexpensive materials; such as, pamphlets, charts and other written material; films, film-strips and slides for audio-visual use; suggestions for equipment, supplies, furniture - and whatever else is salable.	

CLASSIFICATION MATRIX OF NEEDS
ELEMENTARY

I. GOALS	II. ASSESSMENT - OBSERVATION	III. STRENGTHS AND WEAKNESSES
4. KNOWLEDGE OF FACTS, CONCEPTS & GENERALIZATION	4. Collectively, children seemed capable of describing verbally some of the information studies in science units. There was limited opportunity to assess the degree of achievement on this item. Project Design should refer to the achievement test which was recently administered to selected classrooms.	4. The number of units studied were relatively few.
A. Demonstrates knowledge of specific facts, concepts, and generalizations and their historic trends.		
B. Organizes knowledge to support conceptual themes (an increasing understanding of the nature and interactions of matter and/or energy)	In discussing atoms and molecules with one class, there was little evidence that perception of the basic nature of matter had taken place in the children.	A verbal study of a topic which has little relevance to the learner is not likely to develop conceptual understanding at a significant rate.

ELEMENTARY

IV. INSTRUCTIONAL NEEDS	V. AUTHORITY, RESPONSIBILITY, INFORMATIONAL NEEDS	VI. DIRECTIONAL PLANT AND EQUIPMENT NEEDS
4. Teachers need to understand that factual information is only a small part of science education. More important are the perception of generalizations and principles, the increasing understanding of conceptual schemes, and the other goals which are outlined on this matrix. Teachers need to have some understanding of the conceptual schemes which are basic to the understanding of all natural phenomena. The schemes are listed and explained in the *Science Framework for California Public Schools.* Conceptual schemes are not taught but are perceived with greater understanding through the years as the learner has meaningful contacts with his environment. The classroom science program should provide meaningful contacts which continually reinforce the conceptual schemes.	4. Coordinate in-service programs which clarify the subject matter and conceptual schemes in the sciences.	4. Provide in-service programs. Convey the needs of classroom teachers to local teacher training institutions.

ELEMENTARY

VII. COORDINATIVE - SUPPORTIVE NEEDS	VII. SOLUTIONS AND RECOMMENDATIONS (IF ANY)
4. The science instructors in the elementary teacher training program should strive to teach science courses to elementary teachers as they are expected to teach in the classroom. Guidelines for such instruction are included in the California State Science guide.	

CLASSIFICATION MATRIX OF NEEDS
JUNIOR HIGH

I. GOALS (Science Framework for California Public Schools)	II. ASSESSMENT - OBSERVATIONS	III. STRENGTHS AND WEAKNESSES
1. VALUES, ASPIRATIONS, ATTITUDES for Personal Involvement A. Demonstrates curiosity Functional needs beginning on page 14n.	1. In some schools in advantaged part of city, natural history studies on free choice basis gave excellent opportunity for pupils to follow interests; as indviduals or pairs they used "Life" reference series to gather information' on birds, mammals, fishes, etc. Teachers stimulated attention to adaptations for specific habitat, survival implications, etc. Unfortunately, too much of student motivation was not curiosity but extrinsic desire to improve grade by extra-credit reports at end of semester; still a significant rub-off of interest was apparent even though motivation largely extrinsic. By striking contrast, in seriously disadvantaged area and school, opportunity to develop curiosity and interest in science lessons lost completely due to stereotyped lesson procedure. lesson on skin problems of adolescents based entirely on reading (by poor and non-readers)	1. In advantaged schools, attention to this goal for superior students particularly via the extra credit assignment route, with good use of classroom sets of references. Teachers recognize utter inadequacy of State series in this area; use references to fill gap. Weakness lies in fact that this available to only a few of children in system--those with good reading ability, in schools where teachers will forgo lecture-recitation in favor of individual work. Best success in top sections of best schools and in elective seventh grade classes. Also motivation for studies largely grade-centered. In disadvantaged schools and classes, no evidence that lessons developed either to stimulate or to capitalize on student curiosity even in health

JUNIOR HIGH

I. GOALS	II. ASSESSMENT - OBSERVATIONS	III. STRENGTHS AND WEAKNESSES
	in State text series; answering of true-false quiz, or writing answers to questions on ditto sheets. No introduction, no relating to real world or real problems, no evident interest by students in terms of curiosity about themselves and their own personal needs & problems. In one school a teacher with good background in sociology but deficient science information was highly successful thru discussion technique in stimulating interest and some personal involvement of students in same area of study; less successful in developing responses and active participation since he stayed with teacher-centered approach and did not provide opportunity for pupil response beyond direct answer to his questions.	area in classes where state text is basis and reading-lecture-recitation the procedure. In general teachers reveal a lack of preparation for this kind of teaching assignment. Only where teacher laid aside reading in favor of direct discussion verbally did students become involved. Here the weakness lay in follow-up on involvement--lack of scientific information by teacher prevented productive exploitation of interests, and teacher-centered classroom approach did not permit full student participation.
B. Shows interest in theory building with attention to discrepancies.	Very limited evidence observed in any classes of any schools. No indication that is a real goal for learning	This goal is one receiving much lip-service but little actual operational support throughout education. Teachers observed share this weakness with most of the profession.

JUNIOR HIGH

I. GOALS	II. ASSESSMENT OBSERVATIONS	III. STRENGTHS AND WEAKNESSES
C. Seeks interaction with others.	In optional 7th grade natural history lesson in top school, students worked together to present oral reports based on library study. Reports showed important growth by individuals in group process. Class responses indidated this a continuing process. In one 8th grade (biology) and one 9th grade class (optional, for superior students only) of top-quality school, lab work with IPS (Introd. Phys. Sci.) materials showed good committee processes, and cross-committee action to verify results and seek out solutions to mechanical problems in gear handling. Good classroom dynamics evident. Pupils obviously recognized value of group cooperation for effective replication. In disadvantaged school, where teacher had inherited a structure of classroom anarchy, real (and almost unbelievably effective) changes in social behavior and attitudes had been effected. Pupils appeared to	Values to participants obvious; unfortunately these available only to best students in best schools, in cases where teachers have background and intellectual security. In strongest situations, still a need to make more student-centered. Strength results from use of strong laboratory oriented program in hands of well-trained teachers. In same school, another class taught by non-science teacher involved in socially and intellectually sterile library reference work toward extra-credit report production. Students equally able, but lesson framework unproductive. Strength and vital success in creating social order from anarchy through convincing students that they can function as social group yet still retain individualism--this entirely a product of obvious interest of teacher in the individuals. Weakness in lack of technique to translate social readiness into group activities--discussion groups, other

JUNIOR HIGH

I. GOALS	II. ASSESSMENT OBSERVATIONS	III. STRENGTHS AND WEAKNESSES
	respond to teacher as a person, from position of respect and liking; important evidences here of dawn of social conscience as product of effective interaction of individuals. In other schools the situation was much the opposite.	effective ways for individuals to express themselves and make the social group their own rather than teacher's.
D. Demonstrates scientific integrity.	No significant evidence in lessons observed, but may be inferred as output of optional 9th grade IPS class, since this is built into that programs, and teacher is able.	Absence of pervasive concern for this goal must be considered a weakness of most lessons observed; many had opportunities to captialize, none took advantage of those chances.
E. Identifies values of beauty.	Natural history approaches in best classes of advantaged schools focused natural interest of children on esthetics of animal form and function. Effective use of excellent "Life" reference series and importance of teacher enthusiasm should be stressed here. Much of esthetic appreciation stemmed from ability of well-informed teachers to supplement readings and reports with personal comments and anecdotes.	Again, advantages for only best students in best schools. In other areas of city, use of state text only precludes text-based growth in this area, particularly since contents are above reading competence of pupils. No evidence in these situations that teachers consider this significant goal.

JUNIOR HIGH

I. GOALS	II. ASSESSMENT OBSERVATIONS	III. STRENGTHS AND WEAKNESSES
F. Relates science to other human endeavors.	Comments in foregoing sections apply here.	To repeat and emphasize, wherever course work is textbook-reading-recitation oriented and entirely teacher-centered, there is no evidence that work covered bears any relation to the real world as students see it. In classrooms where students use references for data-gathering, individual reports and group study for reporting on findings, some evidence that class work seen in relation to human endeavors. This situation correlated with superior students and superior teachers.

CLASSIFICATION MATRIX OF NEEDS
JUNIOR HIGH

I. GOALS	II. ASSESSMENT - OBSERVATIONS	III. STRENGTHS AND WEAKNESSES
2. SCIENTIFIC MODE OF INQUIRY A. Identify problems	2. In best schools, and in best classes, some incidental teacher effort at identification of content-oriented problems--e.g., what differences can be found between animal adaptations for aquatic vs. terrestrial environments? Also, effective use of IPS material can be expected to develop skills in this area. In disadvantaged school, the sociologically oriented teacher who has been so successful in creating social order from anarchy left him by predecessors flatly stated that it is impossible to move to problem-oriented work with these students. In both advantaged and disadvantaged schools where work was textbook oriented, no evidence of any attention to real (content-centered) problems or to entire concept of scientific inquiry as a goal in education. Only problem apparent was that of finishing assignment.	2. In best schools, teachers show strengths in (limited) concern for development of scientific modes of inquiry. Even in these schools, this is more a teacher than a pupil concern. This position of pessimism regarding problem-approaches reflects inherent difficulty in the task; also the weakness of assigning teachers lacking preparation for the task. Weakness apparent in discussion of observations. Weakness derives from lack of acceptance of goal as either important or achievable. Even if goal is accepted in theory, it cannot be served effectively by textbook-dominated instructional patterns. If school or district consider entire area of scientific inquiry important, funds must be assigned to establishment of classrooms which permit laboratory

JUNIOR HIGH

I. GOALS	II. ASSESSMENT - OBSERVATIONS	III. STRENGTHS AND WEAKNESSES
	In some disadvantaged schools major emphasis was placed on students answering questions on dittoed sheets. No discussion, work highly individualized. Teachers reported students have a sense of accomplishment in answering the questions (which essentially amounts to rewriting sentences or phases in text. Little evidence of introduction to the lesson--no definition of new terms except shouted (and often inaccurate) definitions over the chatter of the children as the work progressed. No attempt to relate work in any way to real problems of group. (I am sure there were problems in the lesson--how can I answer questions I cannot read; what system shall I use for guessing true or false; how can I survive the next 40 minutes until the bell will ring?) As observers, we were appalled at the built-in assurances of negative values from such	instruction; teaching assignments must give priority to recruitment and assign of teachers trained in science and in teaching for inquiry values. (n.b., in all of worst cases noted in this admittedly small sampling, teachers were not science majors and/or had not been educated to use inquiry approaches to science teaching. Also, in all cases classrooms were not fitted for most effective approaches; in most cases could not have been used for laboratory work.)

I. GOALS	II. ASSESSMENT-OBSERVATIONS	III. STRENGTHS AND WEAKNESSES
	a lesson approach. In the context of the goal--Identifies problems--and the broader objective of development of techniques for scientific inquiry, these sort of lessons have most pervasive negative effects, producing obligate intellectual dishonesty in guess-answers in order to meet an impossible assignment, and one of no apparent significance to the pupil.	
B. Formulates hypotheses.	Extremely limited observations of this process in twelve classes visited. Some indirect evidence that hypotheses are developed through natural history studies in (optional) seventh grade class; certainly in the IPS program this element of scientific inquiry should be a part of total.	This important (indeed crucial) middle element of scientific inquiry is the one most frequently missing from instruction, even where teachers are striving hard for inquiry goals. Even in best classrooms observed, stress was on subject-matter--therefore on product of science--rather than upon process of conclusion development.
C. Generates data.	In best situations, best schools, data collection was effective in use of reference books and (in 9th grade IPS program) in laboratory work. However,	Even routinized collection of data has very real values when it involves using other than textbook sources; these activities are very significant strengths in those classrooms

JUNIOR HIGH

I. GOALS	II. ASSESSMENT OBSERVATIONS	III. STRENGTHS AND WEAKNESSES
	activities which would encourage them to generate data themselves.	
D. Draws inferences. E. Predicts events. F. Generalizes.	These elements of the scientific inquiry approach were not observed except isolated classrooms. No district wide effort observed.	General comments in sections above apply here. Two teachers observed were realizing major gains for students through this natural history approach (same school).

JUNIOR HIGH

I. GOALS	II. ASSESSMENT OBSERVATIONS	III. STRENGTHS AND WEAKNESSES
	reference work for natural history studies was to set pattern, using references available in classroom (in 4 rooms visited); thus with little area for selection since in most cases only a single book provided materials appropriate to assignment. Indirect evidence of free use of library and thus development of search techniques; however, reports heard were essentially direct results of use of encyclopedias, in some cases without apparent comprehension of materials reported. In disadvantaged school and classrooms, text assignment techniques called for unrealistic data development, since students were not able to read materials, and assignments lacked cogency of relationship to real world and to personal problems. Teacher lecture-recitations observed were more successful in relating subject matter to needs and interests of children, but teachers did not follow with pupil-centered	observed. Greater values would result if wider choice of reference sources were available, and if reporting requirement for full definition and explanation of terms; encouragement of use of visual aids in form of diagrams, charts, graphs, etc.) Weaknesses implicit in statement at left. It should be noted that only properly prepared and oriented teachers can do other wise, and that even for the very best teacher the task is difficult in such disadvantaged areas where backgrounds and abilities of pupils are limited by environmental deprivations, inertia, apathy.

I. GOALS	II. ASSESSMENT OBSERVATIONS	III. STRENGTHS AND WEAKNESSES
3. SKILLS WITH EQUIPMENT, MATERIALS, COMMUNICATION. A. Constructs & uses laboratory apparatus	3. IPS (optional grade 9 laboratory classes showed effective mastery of material provided, including apparent understanding of equipment and its use. Only in three classes out of 12 observed was laboratory work going on at time observed; however, in two schools of advantaged area, evidence of lab work from previous days, and classrooms well appointed and equipped. In most disadvantaged school classrooms, lab work would be impossible on individual slant-topped desks, classroom so crowded with desks no room for any tables except for small inconvenient demonstration table in front of room. No chance for this goal.	3. Strength of individual involvement in handling gear well documented in IPS program which is designed particularly to serve this goal. Simple equipment so inexpensive that each pair of pupils has his own set, with teacher instructions well enough worked out to assure frequent success in handling--all contribute. Weakness of non-laboratory courses in rooms precluding student use of equipment include: -No chance for pupils to experience the challenges and the fun of problem attach though experimentation; -no opportunity to develop even rudimentary basic skills of measuring, weighing, handling materials important to every citizen; -no chance for mind developing activities calling for accuracy, precision, etc. -no recruitment possibilities for future scientists.
B. Selects Appropriate source materials.	In natural history reference work in best schools, evidence that one instructor guided students to seek out books appropriate to their	Values apparent in best situations. Even here, need for wider choice of reference materials in rooms in order to promote freer choice by

I. GOALS	II. ASSESSMENTS OBSERVATIONS	III. STRENGTHS AND WEAKNESSES
	abilities with particular attention to advanced competencies.	pupils for individual needs and competences.
C. Accurately records & organizes observations.	Comments in earlier sections indicate this goal approached in best situations, not so in disadvantaged school. Here even demonstrations are rarely (if ever) used and the only possible exercise is copying of materials from text or from blackboard by students of low verbal ability.	Quite obviously, these goals cannot be served significantly in textbook dominated situations in which even demonstrations are not used.
D. Communicates effectively with appropriate terms and symbols.	Comments earlier relative to IPS program apply here, since this laboratory-oriented program encourages effective use of quantitative data, report development, etc. Natural history classes reported showed strengths and weaknesses in technique as indicated.	Real service to this objective in better schools; none at all observed in disadvantaged school. Even in best situations, this goal deserves special attention in terms of criteria for evaluating and improving student reports.

JUNIOR HIGH

I. GOALS	II. ASSESSMENTS OBSERVATIONS	III. STRENGTHS AND WEAKNESSES
4. KNOWLEDGE OF FACTS, CONCEPTS, AND GENERALIZATIONS A. Demonstrates knowledge of specific facts, concepts, and generalizations and their historic trends. B. Organizes knowledge to support conceptual themes.	4. In advantaged schools and classrooms, ample evidence that this objective well-served. IPS program for 8th or 9th grade (optional course) and natural history approaches in grades 8 and 7 all effective in fact development, and evidence that facts will lead to concept formation and generalization (e.g. special adaptations of vertebrates for survival lead to concepts of evolution, ecological community and ecosystem, implications for conservation, etc. IPS work on qualitative analysis of sludge leads to generalizations regarding techniques of matters of solubility, critical temperature relations to solubility, vaporization, etc. In less advantaged situations, self-defeating nature of teaching (textbooks only for poor or non-readers) assures that knowledge growth will be minimal.	4. Real strengths in best situations in effective development of information background, including some differentiation of activity in terms of ability level. IPS program particularly effective because performance-based. Natural history approaches showed particular strengths in attempts by teachers to lead from specific characteristics of animals to generalizations relating to habitat preferences, limiting factors of environment, implications for evolution and various ecological concepts. In disadvantaged situations, stress on vocabulary for students weak in verbal skills a self-defeating weakness. Failure to relate reading assignments in any way to real-life assignments and needs further assures failure in fact or concept development since pupils see no relevance.

JUNIOR HIGH

IV. INSTRUCTIONAL NEEDS

1. Observations covered wide range of teacher attitudes and competences:

In best situations, well-prepared science teachers with strong professional motivations were effectively instructing able classes under nearly ideal physical conditions. Needs to be met in order to enhance these situations might include the following:

1. Establishment for all classes (not just best or through additional electives) of laboratory emphasis, with stress on use of simple equipment, such as IPS or similar program.
2. Further orientation and education of these able teachers toward service to goals of State framework, particularly in relation to scientific mode of inquiry and to student attitudes toward theory building, scientific integrity, and relation of science to other human endeavors.
3. Development of evaluational criteria and procedures which reward progress in areas noted above (#2), and discard artificial motivations and bil build-in inequities of extra-credit report approaches.

V. AUTHORITY, RESPONSIBILITY, INFORMATIONAL NEEDS

1. Obvious interest on part of some principals and other administrators in maximal efficiency of science teaching, & facilitation of this effort by provision of good equipment and selection and assignment of well-prepared teachers. At opposite extreme, in disadvantaged areas indications of apathy/and-or defeat at administrative levels.

Major system-wide needs for enhanced administrative facilitation of science teaching in the junior high schools would include:

1. Development of district leadership in science curriculum matters, toward goals of system-wide coordination & support of science instruction that is:
   a. laboratory-centered;
   b. vertically coordinated with elementary and high school programs;
   c. broadened in scope, probably with continuation of 8th grade physical science emphasis, but with additions at other grades, particularly in 7th grade natural history areas of emphasis;
   d. diversified in approach and content to allow for

VI. DIRECTIONAL PLANT AND EQUIPMENT NEEDS

1. Extreme range of facilities observed in schools visited;

Best situations featured fine buildings, even though not new. Rooms large, well lighted and painted, with flat-topped student tables appropriate for laboratory programs (2 students/table, 36 stations maximum). Good equipment in plentiful supply, including microscopes excellent demonstration equipment, & fully adequate individual laboratory gear. IPS kits (one complete kit per pair of students) new and in full use--excellent resource for creative teaching. Fine reference book sections in these well-appointed schools.

At extreme opposite end of scale, in disadvantaged section of city an old building has been allowed to decay over many years. Rooms box-like, badly lighted & kept up. No possibility of laboratory work since only table in room is instructor

JUNIOR HIGH

IV. INSTRUCTIONAL NEEDS	V. AUTHORITY, RESPONSIBILITY INFORMATIONAL NEEDS	VI. DIRECTIONAL PLANT AND EQUIPMENT NEEDS
(at one school, entire classroom effort degraded by teacher-pupil concern for extra-credit. Instructional needs in less-advantaged situations are implicit from previous pages. Particular attention must be directed to laboratory approaches, pupil involvement in relation to real-life problems in interests; particular attention to use of skills and approaches other than textbook recitation alone. Need for classroom management that includes order & politeness as basic social pattern, & provides for small-group dynamics as mechanism for exchange of ideas.	different competences of pupils, but with equal opportunity for appropriate learning in disadvantaged areas. e. Organized to serve goals of State framework (per check-list, this study). 2. Insistence that science courses be taught by science teachers who have received some education in modern methods of instruction.	demonstration one which also serves as textbook depository and general service area Slant-top student desk. Gear obsolete, damaged, mostly useless. Unbelievable!

JUNIOR HIGH

VII. COORDINATIVE - SUPPORTIVE NEEDS	VIII. SOLUTIONS AND RECOMMENDATIONS (IF ANY)
1. System-wide needs: Teachers and administrators at all schools visited conveyed a feeling of discouragement over general lack of community support for schools, as evidenced particularly by Fresno's three-time failure to pass bond elections necessary for building construction and other school improvement needs. School personnel conveyed impression that this is more than just a money matter--that in their eyes it indicates general lack of interest and concern on part of community and community leadership. School personnel could give me no evidence of community involvement in planning or evaluation of educational goals or curciculum patterns. I saw no evidence of effective efforts by schools to enlist such community involvement. (efforts reported were de facto, relating to back-to-school events, committees set up without clear mandates or goals, etc.)	1. To meet major system-wide needs of community support: a. Under leadership of Science Coordinator, with active support from Superintendent and Board of Education (financial as well as moral support!), and with planning participation by selected committee of able science teachers, develop a system-wide science curriculum plan for the secondary schools with concern for the points summarized on 23 (center column: authority needs.)*** b. With such a plan in hand, assemble a blue-ribbon Citizens' Advisory Commission for Science, with membership nominated by schools, city/county government, Chamber of Commerce or similar local group for assistance with modification of the plan, its final approval, its implementation. c. Continue to work with this Commission for community involvement in resource persons for enrichment of teaching programs, aid in financing, etc. d. Development of appropriate community project in support of excellence in science education to serve as community rallying point (e.g., junior scientist program in relation to museum activities, zoo, planetarium, or other facility. ***Secondary science should of course be a continuation of a strong elementary program--K thru 12 planning.

JUNIOR HIGH

VII. COORDINATIVE - SUPPORTIVE NEEDS

2. Disadvantaged areas--particular needs:

Teachers and administrators reported total lack of local (disadvantaged area) involvement with schools-lack of interest in schools or actual antipathy toward schools.

No indication that any particular effort had been made by schools to serve particular and peculiar needs of these areas by appropriately dsigned curriculum approaches, special teaching aids and techniques, special inducements to enlist particularly qualified teachers, etc. No indication that local leaders had taken initiative to encourage schools to do so, or to assit them to make the effort realistic and effective.

Teachers & administrators report the usual problems of school management in disadvantaged ares:

-lack of home & community support for educational goals;
-excessive absence and tardiness;
-active antagonism, vandalism, militancy;
-lack of community assistence with these problems.

VIII. SOLUTIONS AND RECOMMENDATIONS (IF ANY)

2. With special reference to disadvantaged areas:

a. From general community involvement sought above, direct benefits to special areas can be sought, but only if those areas are included at beginning.

b. I urge inclusion of representation from disadvantaged groups and areas in the fabric of the schools by:
   1. Recruitment of minority-group teachers, using modified standards for credentialing.
   2. Use of local para-professionals (cf. high schools)

CLASSIFICATION MATRIX OF NEEDS
SENIOR HIGH

I. GOALS (Science Framework for California Public Schools)	II. ASSESSMENTS - OBSERVATIONS	III. STRENGTHS AND WEAKNESSES
1. VALUES, ASPIRATIONS, ATTITUDES FOR PERSONAL INVOLVEMENT. A. Demonstrates curiosity	Wide range of variation from school to school in achieving this goal. In best high schools located in best section of this city, little evidence of true curiosity to be seen. Lessons subject-matter oriented & grade-motivated. Laboratory work based on manuals, "cookbook operations." Examples: a. Zoology class dissecting rat: so far as could be observed, attention entirely on manipulations that would produce desired answers. No evident interest in function as related to structure observed. Class was orderly but with no indications of intrinsic motivation in terms of real intellectual curosity.	Major weakness in these top quality schools rests with textbook-workbook domination of instruction with its""cookbook" implications. Little room for curiosity based on content when pressures are high for completion of assignments that are structurally oriented, definition dominated. These classes closely resembled those traditional to colleges, which is not a compliment. Major weakness in BSCS materials is time pressures which do not permit average teacher and class to deal with materials outside set curriculum.
	b. 10th grade BSCS biology class dealing with genetics--teacher tried to arouse interest from point of view of curiosity about selves and heredity, but class unresponsive.	(See above paragraph)
	c. Physiology class engaged in variety of activities relating to blook pressure and	Real strength here in obvious interest of students in blood phenomena, both in relation

Functional needs beginning on page 15-1.

I. GOALS	II. ASSESSMENTS - OBSERVATIONS	III. STRENGTHS AND WEAKNESSES
	anatomy of cirulation. Here a much higher intrinsic motivation apparent, in part a product of small-group activity plan and fact that work involved living things including students themselves. Detraction was student preoccupation with getting answers down in notes to questions largely anatomy-definition oriented. Basic interest was high, but stifled by "cookbook" demands. At school in most disadvantaged section of city, students mostly Black, ghetto location, 10th grade biology lessens in two classrooms succeeded in arousing much curiosity about: a. selves--physiology & anatomy of sex and its drives and pressures; b. society--its demands and presures, and reasons for fabric of mores and customs. In other schools, teachers were highly successful in making proper use of the new curricular (BSCS, PSSC, CHEM) materials. Demonstrations and experiments were designed to	to selves and to animals (tadpoles) they were observing. Full values of this enthusiasm blocked by: a. sylabus requirements which called for information not closely related to interests & enthusiasms (structures, definitions, etc.) b. somewhat marginal technical skills in such matters as microscope operation (even though this the end of a second year class). Exciting strengths in success of two courageous and committed teachers in arousing responsivness in pupils not give to such responsiveness. Mechanisms for success were capitalization upon inherent interest of subject by relating it specifically to needs and problems of pupils as adolescents growing up in their particular slice of society. Teachers showed understanding of pupil needs and interests, used vernacular language and approaches to involve pupils and draw out responses.

SENIOR HIGH

I. GOALS	II. ASSESSMENTS OBSERVATIONS	III. STRENGTHS AND WEAKNESSES
	arouse curiosity, to enable students to ask questions, make predictions and inferences.	Teachers less successful in dynamics of discussion handling. Tended to over-ride pupil responses with next items of teacher lesson plan, rather than follow-up of points developed by pupil questions or comments. (teachers young, not long-experienced, dealing with explosive topic with visitor in room-all contributory complications.) Lessons demonstrated effective classroom management, rapport, apparently based upon mutal respect and reasonable trust.
B. Shows interest in theory-building with attention to discrepancies.	Limited evidence from lessons seen in twelve classrooms of six high schools, that this is a major goal of teachers or pupils. Possibly due to time of year and material under consideration.	This is an important goal. If it is not served to at least some extent, it constitutes a significant lack.
C. Seeks interactions with others.	In laboratory work cited on page , small group interaction frunctional and efficient in operational sense. In sex education lessons discussed above, I had feeling that	Major strengths which should be supported maximally in efforts in ghetto school as discussed on this page.

SENIOR HIGH

I. GOALS	II. ASSESSMENTS - OBSERVATIONS	III. STRENGTHS AND WEAKNESSES
	students were awakening to realization of interaction among people as a society goal of some value. This could be most important if true, considering the group and area.	This goal usually receives more lip-service than actual implementation; classes observed no exception.
D. Demonstrates scientific integrity.	No specific evidence in limited sampling that this constitutes significant goal of teachers or of their pupils. In workbook-dominated classes, practices may encourage reverse, since pressure for grades causes students to fake oaservations and answers. Example: Students in better school (but less able class) were making drawings ostensibly from materials before them, but assignment included use of text figure of same material; students I observed were giving only perfunctory attention to lab materials; making drawing from text figure. This is not scientific integrity--rather it is tacitly accepted intellectual dishonesty.	This tacit encouragement of intellectual dishonesty is another major weakness of textbook-workbook domination of instruction, and of stress on content mastery as shown by labelled drawings, memorized definitions, and other traditional elements of zoology and botany.

I. GOALS	II. ASSESSMENTS - OBSERVATIONS	III. STRENGTHS AND WEAKNESSES
E. Identifies values of beauty.	In sex education lecture-recitation in ghetto school, pupils led to see importance of physical beauty in attraction between sexes--to see this as functional biological process to assure procreation. Teachers also worked to develop idea of other kinds of beauty--of character and personality, as basis for family security. Most important, teachers led pupils to see these facts as consonant with biological and social needs. Some evidence of this goal found in BSCS courses.	A major strength, and one of the most exciting attempts at science teaching for personal and social values. As noted on page 15b, teachers only partially successful for a number of reasons, but beginnings were apparent and productive. Weakness lay in tendency to cut off pupil responses in order to move ahead with lesson; also in use of language too vernacular, too "hip." I think a bit more scientific approach possible without losing the fine rapport established.
F. Relates science to other endeavors.	Implications for this goal throughout earlier comments these three pages.	Strengths most apparent in disadvantaged situations. No real evidence of concern for this goal in top classes of top schools where attention appeared to be on content for its own academic values.

I. GOALS	II. ASSESSMENTS OBSERVATIONS	III. STRENGTHS AND WEAKNESSES
2. SCIENTIFIC MODE OF INQUIRY	No evidence from most lessons observed that this general topic constitutes a functional goal. Certainly it should be built-in to BSCS teaching, but lessons I saw did not support this objective regardless of where taught.	Absence of major continuing service to this general objective is a major weakness in any secondary science program. There is massive stress nationally on importance of process in science; courses that continue to confine their operational work to product alone are anachronisms.
	Some comments by specific sub-heading follow:	
A. Identifies problems.	Sex education lessons at ghetto school showed growth in student ability to segregate larger problem of sex into more manageable sub-problems: a. biological stresses accompanying puberty; b. peer-group pressure of gang toward behavior patterns which are gang-approved; c. demands of society which a are product of: 1. custom and past usage; 2. need to develop family ties to protect and support mother and child. Some BSCS classes revealed as attempt to achieve process	Strengths of two sorts; a. pragmatic, helping youngsters to anaylze pressures of their age and time, and seek ways to order lives accordingly. b. intellectual, hopefully leading to recognition of technique in problem-solving, that of reduction of larger problem area to sub-problems, and statement of those sub-problems in understandable form. Note that this kind of approach was not seen at more favored schools; its use unlikely under more "academic" patterns.

SENIOR HIGH

I. GOALS	II. ASSESSMENTS OBSERVATIONS	III. STRENGTHS AND WEAKNESSES
	goals. Much more depends upon the teacher, his philosophy and understanding, than on type of curricular materials used.	
B. Formulates hypotheses.	Lesson described above less successful here; took puils to problems, but did not show signs of next step--analysis of alternatives. (This may have been planned for later date; however, the thrust of its values would be reduced when removed some days from problem-definition.) Teachers not so successful in helping pupils to look toward their own statements. Teachers over-rode pupil comments with next point in teacher lesson-plans.	This middle element in scientific method is difficult in all circumstances, usually not well-served. In this instance I was particularly concerned, as it seemed that problems were raised and highlighted, but constructive alternative answers were not in view. This has pragmatic as well as intellectual weaknesses.
E. Generates data.	In sex education lesson, teachers generated data from group itself rather than traditional academic (textbook) sources less accessable to them. Comments offered earlier are critical of data generation in academic classes of more favored schools.	Extent to which this goal is achieved varied widly from school to school and from teacher to teacher, as observed in actual classroom teaching, and in conferences with teachers. In general classes were not as process oriented as intended by curricular materials used, except in a few classes.

SENIOR HIGH

I. GOALS	II. ASSESSMENTS - OBSERVATIONS	III. STRENGTHS AND WEAKNESSES
D. Draws inferences.	Little evidence of this process.	
E. Predicts events.	" " " " "	
F. Generalizes.	" " " " "	

SENIOR HIGH

I. GOALS	II. ASSESSMENTS OBSERVATIONS	III. STRENGTHS AND WEAKNESSES
3. SKILLS WITH EQUIPMENT, MATERIALS, AND COMMUNICATION. A. Constructs and uses laboratory apparatus.	Students in zoology class, top school, showed reasonable skills in standard laboratory dissection work with rat anatomy. Students in physiology laboratory lacked reasonable skill with microscopes generally; more successful in use of bloodpressure gear. BSCS students in one school were using material and equipment most effectively.	Strength is ability to handle standard laboratory procedures effectively; however, cookbook approaches build efficiency in that context only. Weakness of this approach lies in student inability to function without the "cookbook." Weakness in second year students showing consipicuous inability to use microscope effectively in new situation--corollary of point above.
B. Selects appropriate source materials.	No evidence in any classes observed--and of course no need, given cookbook! (In certain classes)	
C. Accurately records and organizes observations.	cf. reservations expressed regarding observations copied from book rather than from materials (pg.) Workbook tends to encourage recording of data without thinking about it.	
D. Communicates effectively with appropriate terms and symbols.	In 10th grade biolgoy in top-quality school, excellent approach by teacher to definition development through class discussion	Very strong and useful approach to development of definition, using technique which is broadly applicable. Of interest, I did not see this

SENIOR HIGH

I. GOALS	II. ASSESSMENTS OBSERVATIONS	III. STRENGTHS AND WEAKNESSES
	search for key words as group then individuals made responsible for definition construction (remeaning of genetics, heredity in this case). Effective use of classroom discussion technique and vernacular to explore problems important to adolescents in sex education lesson for ghetto area students.	used in any of the advanced classes of better schools; rather they used terms and definitions as supplied by textbooks and workbooks. Strength in fact that thus the teacher can reach pupils with limited work-factors, and can stimulate their own interest and responses. Weakness if teacher than fails to up-grade vocabulary and self-expression competences.
	In 10th grade biology classes, disadvantaged schools, reading materials not useful in too many cases since far above reading competences, and not related to real problems and interests. In one such class, observed pupils reading questions from examination aloud, with objective of supplying answers for review of materials covered. In at least half the cases, pupils were unable to read the questions intelligently.	Weakness in system wherein text selection is for college-preparation students; others must try to use same books. Result is failure to communicate from teacher to pupil; reciprocal failure to build appropriate skills. Need for greater variety of supplementary materials, expecially in reading. Major need for placement into disadvantaged classes of readable materials e.g. Row-Peterson or other lower-graded inexpensive resources.)

SENIOR HIGH

I. GOALS	II. ASSESSMENTS OBSERVATIONS	III. STRENGTHS AND WEAKNESSES
	In no class did I see effective use of graphic techniques--as would have been most appropriate in physiology, and perhaps in zoology. This may have been due to time of year and/or content being studied at the time.	Weakness in that students may perpetuate present inability to read graphs. Drawings made by students may be only imperfect renditions of text illustrations rather than interpretations of their own observations of real phenomena.

SENIOR HIGH

I. GOALS	II. ASSESSMENTS - OBSERVATIONS	III. STRENGTHS AND WEAKNESSES
4. KNOWLEDGE OF FACTS, CONCEPTS, AND GENERALIZATIONS. A. Demonstration of knowledge of specific facts, concepts and generalizations and their historic trends.	Content centered teaching in better schools accept this as major goal. Evidence from lessons observed, indicated stress on facts; less indication of emphasis upon generalizations or concepts, except as noted below:	Curriculum emphasis upon fact-recall alone must be classed as a weakness n in terms of generally accepted goals for science education today, with emphasis upon process in science rather than upon product alone.
B. Organizes knowledge to support conceptual themes.	In 10th grade biology class studying heredity and genetics, teacher sought concept growth, and focus on student's responsibility to better understand rules of heredity as these influence his future through his offspring. In sex education class, disadvantaged area, teacher sought to develop a theme for family organization in civilization as we know it--"human society different than that of bear--" human male expected to remain to aid in rearing of child; not so with bear. This for biological reasons, out of which come human institutions of marriage and family responsiblities.	Strength in this determinded effort to show relation of science to real world and real interests of pupils. Need for understanding of conformance of society's practices to natural causes and principles. This especially important for disadvantaged area, where families may be more bear-like in the context of the analogy developed. Weakness in that of six classes observed, only in these two could it be shown that knowledge led to generalizations and organized knowledge. In other classes, facts were assembled only for themselves so far as could be noted.

SENIOR HIGH

IV. INSTRUCTIONAL NEEDS	V. AUTHORITY, RESPONSIBILITY, INFORMATIONAL NEEDS	VI. DIRECTIONAL PLANT AND EQUIPMENT NEEDS
The following instructionally-related needs merit special mention as general recommendations: 1. Attention to process objectives --problem solv. approaches to learning, stress on attitudes and values to be developed, rather than on product of science (content mastery) alone. 2. Acceptance of block-and-gap approach to planning, with sections of content omitted in order to provide time for concept development. 3. Modifications of evaluational procedures and pressures these impose in regard to removing: a. stress on copying diagrams, definitions, from book directly to notebook rather than development of materials from class observations and discussions. b. stress on extra-credit activities whereby student makes up for past deficiencies by sudden burst of last-minute project work. c. stress on science fair and merit award activities for all --so that course work becomes	The following needs require administrative facilitation: 1. Provide maximum encouragement for meeting instructional needs recommended for consideration at left. 2. Provide district leadership for curriculum re-structuring through the Science Coordinator, with full support from the superintendent and Board of Education, including the following: a. Vertical integration of K - college (with consultation with Fresno State College and Jr. colleges toward best possible coordination). b. Diversification of 10th grade biology to provide reading materials and concept-developing approaches appropriate for slow learners as well as for college prep. (Present curriculum strongly college-prep conditioned--less able students not specifically provided for.) c. Achieve better balance of physical and biological sciences for grades 11 &	In most schools observed good physical plant, with large, airy rooms, good lighting, etc. Student tables suitable for effective laboratory work; model charts, a/v equipment, all better than minimal, in many situations superior, Excellent resources available in Resource Center. For less able learners, inadequate reading resources since texts available are above reading abilities. Need for supplemental materials at lower reading difficulty, yet mature in ideas (e.g. Row-Peterson booklets, *Life* magazine books and other Jr. Hi. materials other than state textbook.

SENIOR HIGH

IV. INSTRUCTIONAL NEEDS	V. AUTHORITY, RESPONSIBILITY, INFORMATIONAL NEEDS	VI. DIRECTIONAL PLANT AND EQUIPMENT NEEDS
4. Development for all classrooms of decor that demonstrates life--aquaria and terraria that are part of lessons, bulletin boards that shift and change to keep up with units, etc.	12. This assessment team challenges extension of special biology courses (zoology & botany especially, advanced biology & physiology less critically) at expense of chemistry and physics. These subjects seriously under-subscribed in Fresno schools. There should be 11-12 grade physical science courses for non-college students, and college students should not be permitted to take another biology course instead of the appropriate physical science courses.	
5. Maximum attention to communication sills-- to upgrading of functional vocabularies, to use of graphs & tables, to development of definitions in terms of the student, etc.		
n.b. By implication, all of needs above reflect observations of shortcomings in some situations.	d. Provide incentive for laboratory teaching by reducing assignments (extra prep period) for teachers engaged in "process" teaching.	

VII. COORDINATIVE - SUPPORTIVE NEEDS

1. Teachers at disadvantaged high school listed as two major problems they face in science teaching:
    a. Low reading ability of pupils, many with competences at grades 5-6, some non-readers (yet materials available for instruction may be difficult even for good readers).
    b. Poor student attitude toward school and education. Teachers indicate that money alone seems strongly motivating--that pupils will work only if convinced that they thus can improve earning power. Otherwise attitudes of "I don't care" and "so what" to school assignments.

Teachers equate many of these problems with community apathy or antagonsims, pointing out that the only way to get parents to school for conferences is to go and get them. Teachers feel that little can be accomplished at school unless the community provides support and backing--that there must be improvements in community environment of children for educational efforts to be effective.

Obviously, these positions are affirmations of general problems faced nationally in seeking to improve educational opportunities for disadvantaged areas. Education can succeed only with community support and assistance.

VII. SOLUTIONS AND RECOMMENDATIONS (IF ANY)

1. With special reference to schools in disadvantaged areas, every effort should be directed to involvement of the local community in the school directly. This can follow two levels, and funds should be sought for both:
    a. Recruitment of teachers from minority groups to serve in disadvantaged schools. This demands modification of teacher certification procedures since many otherwise qualified teacher-candidates cannot meet criteria established for those with advantaged bakcgrounds. (Refer to the U.S. Peace Corps and other national programs for evidence of achievements by minority-group teachers who were admitted to programs in spite of deficiencies in formal background.)
    b. Recruitment and training of para-professionals from local ghetto sources to assist teachers in the classroom with more routine tasks. While it is true that there may be a shortage of people available with proper training already, people can be selected for general character, then trained on the job. Benefits of such a system are too obvious to need discussion, but they include a needed incentive for bringing teachers to these disadvantaged schools. Good teachers could be attracted to come and to stay if they were provided good help with routine tasks, particularly if such help give them access to community support through participation.

METHODOLOGY DETAIL

Elementary

There are 52 elementary schools in the Fresno City Unified School District. The assessment of the elementary school science program was made on the basis of visitations to a sampling of eight schools. These eight schools were selected by Project Design as a representative cross section of the Fresno City community based on ethnic groups and socio-economic levels. The visitations were made from May 22 through May 24, 1968. The schools visited and their uniquenesses were:

Calwa and Aynesworth schools: over 50 percent Spanish surnames
Carver and Kirk schools: over 50 percent Negro
Figarden School: over 50 percent white and low income
Pyle and Wishon schools: over 50 percent white and middle income
Birney School: over 50 percent white and high income

The time spent at each school ranged from one and one-half to three hours during which time conferences were held with classes of students. At each school, two to four classes at varying grade levels were selected for visitations. Approximately one half hour was spent in each classroom. The following table shows the frequency of visitations by grades.

Grade Level	K	1	2	3	4	5	6	
Number of classroom Visitations	4	3	3	3	4	4	4	Total 25

The procedure followed at each school consisted of an initial interview with the building principal. This meeting revealed the nature of the science program in the school and the extent of available science equipment and materials. The visitation schedule to selected classrooms was also arranged through the principal. Usually, three classrooms at varying grade levels were requested and the principal selected the three teachers to be visited. During each visitation, it was possible to spend 15 to 20 minutes discussing the classroom program with the teacher. When circumstances permitted, a discussion was held with the children. In 25 classroom visitations, there was only one opportunity to see a science lesson in operation. In six schools, there was an opportunity to examine the available library resources on science topics.

Junior High

Since time did not permit the evaluation team to observe all science teachers in the fourteen junior high schools the Administrators of Project Design, with the assistance of the Fresno science supervisor, Mr. Shive, was asked to randomly select six junior high schools, representative teachers and classes, which were to be given a standardized science test, and with the remainder of the schools visited by members of the committee. The six schools selected for the testing program were: Addams (white 62%, Spanish 33%); Ahwahnee (white 90%); Sequoia (Spanish 49%, white 43%); Sierra (white 92%); Tioga (white 91%); and Yosemite (white 72%, Spanish 22%). These schools are quite representative of the junior high schools in Fresno with respect to race and/or color.

The science test selected for the study was the Portland Science Test, 1965 Edition, published by the Portland Public Schools, Portland, Oregon. This is a Process-Product test designed for students in the science in the Portland district. It has been given to thousands of students, its validity and reliability determined and norms established. The following table (Table 1) reveals the results of the test and compares test results of pupils in the Fresno School District with established norms for Portland.

Table 1 - Scores on Portland Science Test

School	Number Students		Process Score	Product Score	Combined Score
Addams	63		42.07	40.65	41.39
Ahwahnee	108		47.03	49.5	47.61
Sequoia	96		40.93	40.38	39.53
Sierra	126		46.77	49.69	47.07
Tioga	97		43.61	46.56	43.86
Yosemite	104		43.45	45.05	42.11
Total	594	Aver.	44.42	45.76	44.03
Portland Norm	5263		40.70	50.20	50.40
Difference in Scores Fresno and Norm.			6.28	4.44	6.37

Table 1 reveals that two schools, Ahwahnee and Sierra approach the Portland norm for 8th grade students, while the other schools are apparently significantly lower, possibly at the .01 level. (Time did not permit complete statistical treatment). The average difference between the Portland schools and the Fresno City schools approaches one standard deviation on the process scores and the combined scores (Process and Product). With the exception of two schools Product Scores were higher than Process Scores on this test.

Differences in average scores between Portland and Fresno may be attributed to the rather limited science program in the latter district in grades K-6 and to the fact that science is usually only offered on a required basis in the 8th grade rather than in 7th and 8th as is true in Portland.

In general the test reveals the status of process-product teaching in the junior high schools tested. Observations made in the other junior high schools, by the assessment team, tended to support this objective evidence. Major emphasis in the teaching-learning situation was on content (product), with process being used, or even mentioned, by few classroom teachers. This does not mean that process was not emphasized, at some time during the year, by all teachers, but was not prominently used during this evaluation.

The various junior high schools revealed extremes in facilities, equipment, supplementary materials, methodology and teacher background and preparation. The following summary using the matrix table specifically points out strengths and weaknesses of the program and the steps that may be taken to improve the program. Again the reader is reminded that the assessment of the junior high school program is based on limited evidence obtained through use of one standardized test and classroom visitations. A more complete analysis could have been made had the evaluation extended throughout the year.

Senior High

Six of the seven senior high schools (excluding - Special Education) were visited by either Dr. Harville or Dr. Williamson. Selected classes were observed, where possible conferences were held with science teachers and with administrators. The senior high schools represent great extremes in buildings, facilities and equipment, with Hoover and Bullard having excellent facilities, and Edison and Roosevelt very limited facilities. In general, the teachers are well qualified for their teaching assignment, are acquainted with and/or using the new science curricular material, and for the most part, the science taught is laboratory oriented.

The assessment team believes that a serious imbalance exists in the total science program between the biological and physical sciences.

Table II reveals that 74 percent of all science courses taught in the Fresno high schools are in biological sciences, and 24 percent in the physical sciences. This is a serious imbalance. The thirty-five classes in chemistry, in a total secondary school population of 11,875, is far below the national average in these fields, as is 19 classes in physics. The 8 classes in Introductory Physical Science leaves little opportunity for students not college bound to explore the physical science area. The twenty-three courses offered in Advanced Biology (including Zoology and Physiology) appears to be used instead of, rather than in addition to, courses taken by students in the physical sciences. The assessment team seriously questions the real value of a second year course in any science area that is taken without adequate breadth of science preparation in other realted areas.

The nature of our modern society, its many problems, and predictions for the future demands a high level of scientific literacy on the part of all students, thus science courses should be provided to meet the needs of a wide range of individual differences.

The high school observation matrix evaluates the high school science program in terms of the State Department of Education's Preliminary Science Framework for California Public Schools. In addition to program strengths and weaknesses, instructional needs, authority and responsibility to correct weaknesses, and plant and equipment needs are suggested.

TABLE II

ENROLLMENT IN THE BASIC SCIENCES IN FRESNO HIGH SCHOOLS

		Biology S.	Biology BSCS	Zoology	Adv. Biology	Biology-Otto	Biology H.	Physiology		Chemistry	Int. Phy. Sci.	Physics	Physics H.	Physics Law	Aviation	
Bullard	1,404	2	13	6	1		2		24	4		1	1			6
Edison	1,025	8	7						15	2	1	1				4
Fresno	2,376	7	25	2				2	36	8	1		4			13
Hoover	1,717	6	34		4	2			46	7	1	4				12
McLane	2,688	6	27	3				2	38	9	3	2				14
Roosevelt	2,441	10	22	2				1	35	5	2	2	2	2	4	17
DeWolf	224		3						3							
Total	11,875	39	131	13	5	2	2	5	197	35	8	10	7	2	4	66
Percent of Field		20	66.5	6.6	2.5	1	1	2.5		52	12	15	10	3	6	
Percent of Total Offerings in Science		14.8	50.0	4.8	1.0	.8	.8	1.8	74	13.3	3	3.8	2.7	1	2	26

RECOMMENDATIONS:

(Grouped according to areas of responsibility so far as possible).

1. Physical Facilities--buildings, books, equipment.

    a. Provide for disadvantaged areas of the city a physical plant equal to that provided the best areas.

    b. Furnish all science rooms in junior high and senior high to permit individual student laboratory work. As minimum this requires some perimenter tables and sinks, also flat-topped student desks or tables.

    c. Provide appropriate simple equipment (per curriculum decisions, df. section C) for individual or two-student use in all Junior High science classes.

    d. Supply supplementary reading materials at reading levels appropriate to less able students enrolled in many junior and senior high school science classes (e.g. Row-Peterson Unitexts, and other supplemental reference materilas).

2. General Administration Responsibilities.

    a. Insist that science courses by taught by properly perpared science teachers, particularly in the junior high schools where at present too many classes are being supervied (not taught) by persons without adequate preparation in the sciences.

    b. Provide necessary authorization and support for a complete science curriculum revision, with a major leadership role to be assumed by the district offices.

    c. Recruit appropriately prepared science teachers and para-professional educational assistants, for service in schools of disadvantaged areas of the city, offering incentives which will attract the best qualified persons for the task.

    d. Seek such modifications in credentialing requirements as are necessary to facilitate recruitment of teachers from minority races for service in disadvantaged areas of the city.

    e. Offer incentives for creative laboratory-oriented teaching, particularly in relation to inquiry approaches, by assignment of an extra preparation period (hence lighter teaching load) to teachers so engaged.

f. Encourage and fund as necessary a planned sequence of special in-service workshops to retain experienced teachers in inquiry approaches to learning, and in use of such new curriculum materials as Introduction to Physical Sciences, and the Earth Sciences program.

g. Negotiate with Fresno State College to secure assignment of student teachers in science to disadvantaged schools, rather than primarily to best classes in best schools.

3. Curriculum Development Responsibilities.

a. Establish a Science Curriculum Review and Development Task Force, with administrative mandate to revise the Fresno Unified School District science sequence, giving full consideration to the principles developed by Project Design, as supplemented by additional recommendations to be developed by appropriate local groups.

1) This Task Force should be led by an aggressive and highly competent Science Coordinator, who is given appropriate administrative authority, and clerical and technical support.

2) The Task Force should include working committees composed of selected teachers from the Fresno schools. At minimum, three should be teacher committees for elementary science, junior high general science, senior high science; there also should be a combined teacher-administrator committee to deal with vertical integration, including relationswith local colleges (continuing education of high school graduates, relations of student teacher involvement, etc.)

3) The Task Force should have consultative help and community liaison assistance from a Citizens' Advisory Commission for Science, representative of the broadest possible spectrum of the greater Fresno community.

4) Outside professional consultative assistance should be provided as necessary.

b. Give major consideration in the K-12 revision of the science curriculum to the following gneeral points:

1) Balance among science disciplines mjst be achieved in the K-12 sequence, with full recognition that many students will never complete that sequence. (Therefore, reasonable balance must be achieved at points earlier than grade 12; perhaps by grade 10.)

2) The K-12 sequence must provide a total meaningful experience in science for non-college bound students. It also must match reasonably well with local college programs for effective preparation of college-bound students.

3) Science instruction at all levels must be process-oriented, with attention to modes of scientific inquiry. Science instruction therefore must include at all levels a functional laboratory component.

4) Junior high science must achieve a broader base, with all instruction laboratory-oriented, and (probably) a 7th grade life-science natural history component to balance the 8th grade physical sciences.

c. Seek to remedy certain serious imbalances and deficiencies in the present Fresno science curriculum, including (but not limited to) the following:

1) Lack of adequate laboratory work in most junior high school physical science classes; therefore absence of realistic exposure to the physical sciences for most students in the Fresno K-12 system. (Since very little physical science work is included in elementary schools, and fewer than one-fourth of the Fresno students take physical science course work in high school, this deficiency is serious, both for college and non-college students.)

2) Seriously deficient physical sciences offerings in the senior high schools. Strengthen these by:

(a) Providing more realistic course work in physics and chemistry, with greater attention to principles, and to applications and implications of the sciences.

(b) Development of physical science courses specifically designed for non-college students.

(c) Curtailment of proliferation by biological sciences in grades 11 and 12, where this proliferation is used to substitute a second biological science course for a (much needed) physical science class. Advanced biology courses as a general rule should be open only to students who already have completed a physics or chemistry course.

(d) Careful examination of premises underlying courses in zoology or botany for high school, both in terms of point (3), and in terms of appropriate articulation with colleges.

(e) Consideration of advanced placement approaches for able science students, permitting one-year acceleration of courses (e.g. biology in grade 9; Chemistry, grade 10; Chemistry, Physics, or other advanced courses, grades 11-12).

3) Lack of properly coordinated multiple-tract programs in science.

d. As first-vintage suggestion for centers of emphasis, the following might best fit existing Fresno patterns, and still provide an appropriate balance:

1) Materially strengthen elementary science on all fronts so far as possible.

2) Continue the 8th grade required science core as a physical science emphasis, but keyed to one of the laboratory-centered programs such as I.P.S. or the Earth Sciences program.

3) Develop at least a semester of 7th grade and/or 9th grade science (required) around a biological natural history and health emphasis.

4) Continue 10th grade biological science requirement, but with more realistic multiple-track organization, and particular attention to the needs of the slow learners and poor readers.

5) Develop multiple-track physical science offerings for grades 11-12.

4. Teacher-related Recommendations.

a. Develop teaching methods consistent with curriculum goals (see section 3 preceding), with particular attention to inquiry approaches and realistic laboratory experiences.

b. Reduce dependence on textbooks and workbooks, with concommitant over-stress on verbalization and definition. At the same time, devise ways to insist that laboratory drawings by made from actual materials rather than from text figures, that definitions be in the words of the student, not those of the text author, etc.

c. Devise evaluational instruments that measure accomplishments in addition to fact recall. Avoid excessive use of extra-credit assignments which are added on to point totals to obscure the record of objective achievement of the student.

d. Encourage group dynamics in the classroom through small-group discussion techniques, use of investigative teams for problem-solving (beyond the usual two-student approach to dissection work) etc.

5. Community-related recommendations.

Without strong community interest and active participation, schools may begin to operate in a relatively sterile vacuum. Major efforts must be mounted to involve the greater Fresno community with the schools, and particularly to enlist local disadvantaged neighborhoods in an enlightened self-help program. the following steps should be considered:

a. Involvement of the community in curriculum planning and evaluation, by way of the Citizens' Advisory Commission for Science charged with the responsibility of continuous study and evaluation of the science program.

b. Enlistment of community moral and financial support for school improvement, by way of this and other bodies.

c. Recruitment of teachers of minority-group background for active participation in Fresno's educational development of disadvantaged areas. (This recommendation includes establishment of modified credentialing standards to make this possible.)

d. Recruitment from among minority groups of the local community of para-professionals to serve as teacher-aides in the schools of their community, and development of in-service programs to train these new teacher-aides for their jobs (clerical and technical assistence of classroom teachers and administrators).

e. Creation via these locally recruited para-professionals of a functional communication link between school and community, by means of which the local community may become committed to involved in the schools, their goals, and their programs.

f. Development of requisite financial and other support for these programs and projects.

Respectfully submitted,

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Directions for Administering

PORTLAND SCIENCE TEST

(Materials: a pencil, a Portland Science booklet, and the answer sheet for P.S.T.)

THE TEST YOU ARE GOING TO TAKE NOW IS SCIENCE.

STUDY THE INFORMATION ON THE COVER OF YOUR BOOKLET.

(Give students time to study the cover.)

TURN TO PAGE C AND ARRANGE YOUR ANSWER SHEET THE WAY THE COVER INDICATED. YOU NOW HAVE BEFORE YOU AN EXAMPLE OF THE TYPE OF ILLUSTRATED QUESTIONS TO BE FOUND IN THIS TEST. QUESTIONS ON THE LEFT ARE "HOW WE FIND OUT", OR PROCESS QUESTIONS. QUESTIONS ON THE RIGHT DEAL WITH "WHAT IS KNOWN", OR PRODUCT. NOTICE THAT THE QUESTIONS ARE NUMBERED FROM LEFT TO RIGHT.

LOOK AT THE PICTURE ABOVE, THEN READ QUESTION NUMBER ONE.

THE PICTURE SHOWS A WAY TO MEASURE:

A, FORCE OF GRAVITY; B, VOLUME; C, DENSITY;

D, MASS; E, ALL OF THE ABOVE

SINCE THE BEST ANSWER IS MASS, THE SPACE FOR CHOICE D IS BLACKENED.

NOW READ QUESTION NUMBER TWO ON THE RIGHT.

MASS OF AN OBJECT CAN BE EXPRESSED IN UNITS OF:

A, GRAMS; B, OUNCES; C, TOOTHPICKS;

D, MARBLES; E, ANY OF THE ABOVE

SINCE THE BEST ANSWER IS ANY OF THE ABOVE, THE SPACE FOR CHOICE E HAS BEEN BLACKENED.

ANY QUESTIONS?

YOU WILL HAVE FORTY MINUTES FOR THE TEST.

ON THE ANSWER SHEET YOU WILL BEGIN MARKING YOUR ANSWERS ON THE BOTTOM HALF (P.S.T.) - QUESTIONS ONE THROUGH SIXTY. (Show)

BE SURE YOU MARK YOUR ANSWER IN THE ANSWER ROW THAT HAS THE SAME NUMBER AS YOUR QUESTION.

WHEN I SAY BEGIN, TURN THE PAGE AND START.

READY? BEGIN!

(Note the exact time and write it down.)

(At the end of exactly 40 minutes, say:)

STOP PLEASE! CLOSE YOUR TEST BOOKLETS IMMEDIATELY.

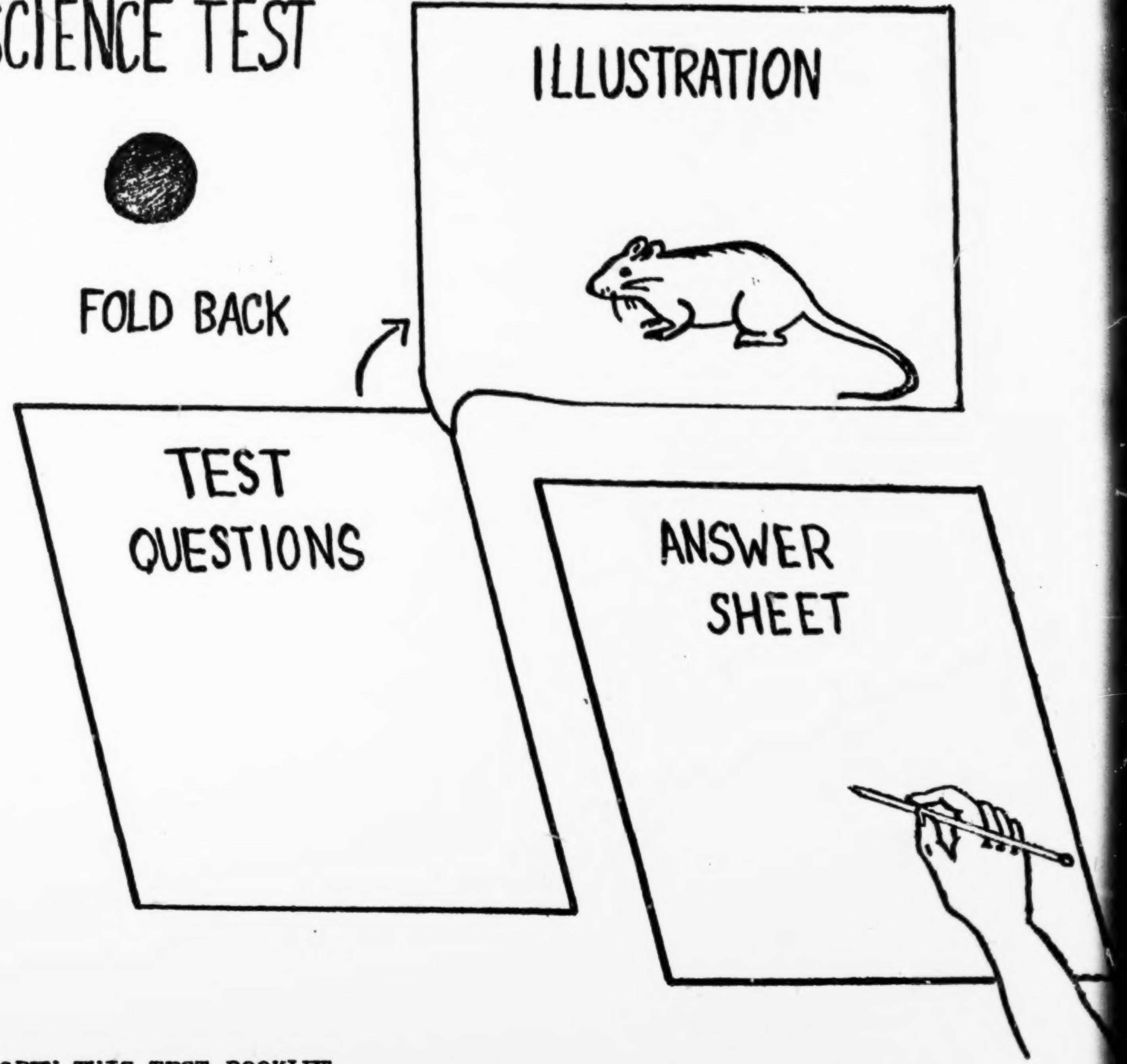
(Have students carefully detach marked S.S. Skills and P.S.T. Answer Sheet from their pad and pass it in.)

If this concludes the testing for the day, collect all materials.

Otherwise, collect any material not needed for the following test.

1966-1967 Edition - Form A

PORTLAND SCIENCE TEST



PLEASE DO NOT OPEN THIS TEST BOOKLET

LOOK AT THE COVER. Above is a picture of the way the test booklet has been designed to be used. Notice that the sheets are stapled in the right-hand corner, therefore, you turn the pages from the left-hand side and fold back as shown. Each page of test questions refers to a picture.

Right-handed students may place their answer sheet as shown. (Left-handed students should place their answer sheet above the test booklet in the space marked ●). This enables one to see the picture, the questions and the answer sheet at one time.

Do not turn the page until you are told to do so.

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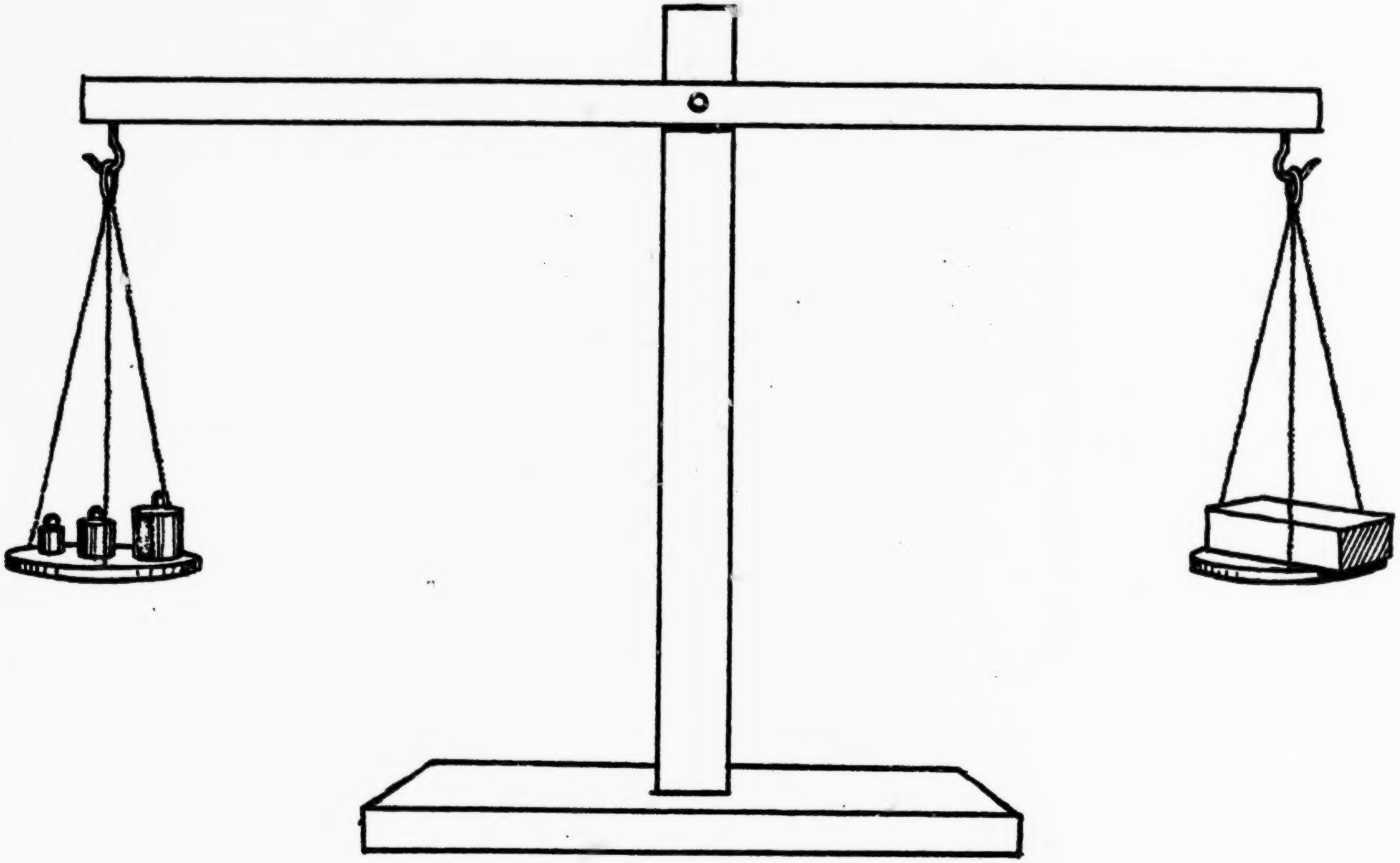


You now have before you an example of the type of illustrated questions to be found in this test. Questions on the left are "How we find out": Process. Questions on the right are "What is known": Product. Notice that the questions are numbered from left to right.

Look at the picture above, then read question number one.

HOW WE FIND OUT (PROCESS)	WHAT IS KNOWN (PRODUCT)
1. The picture shows a way to measure:	2. Mass of an object can be expressed in units of:
A. force of gravity	A. grams
B. volume	B. ounces
C. density	C. toothpicks
D. mass	D. marbles
E. all of the above	E. any of the above

Since the best answer is mass, the space for choice D is blackened.

Now read question number two on the right.

Since the best answer is any of the above, the space for choice E has been blackened.

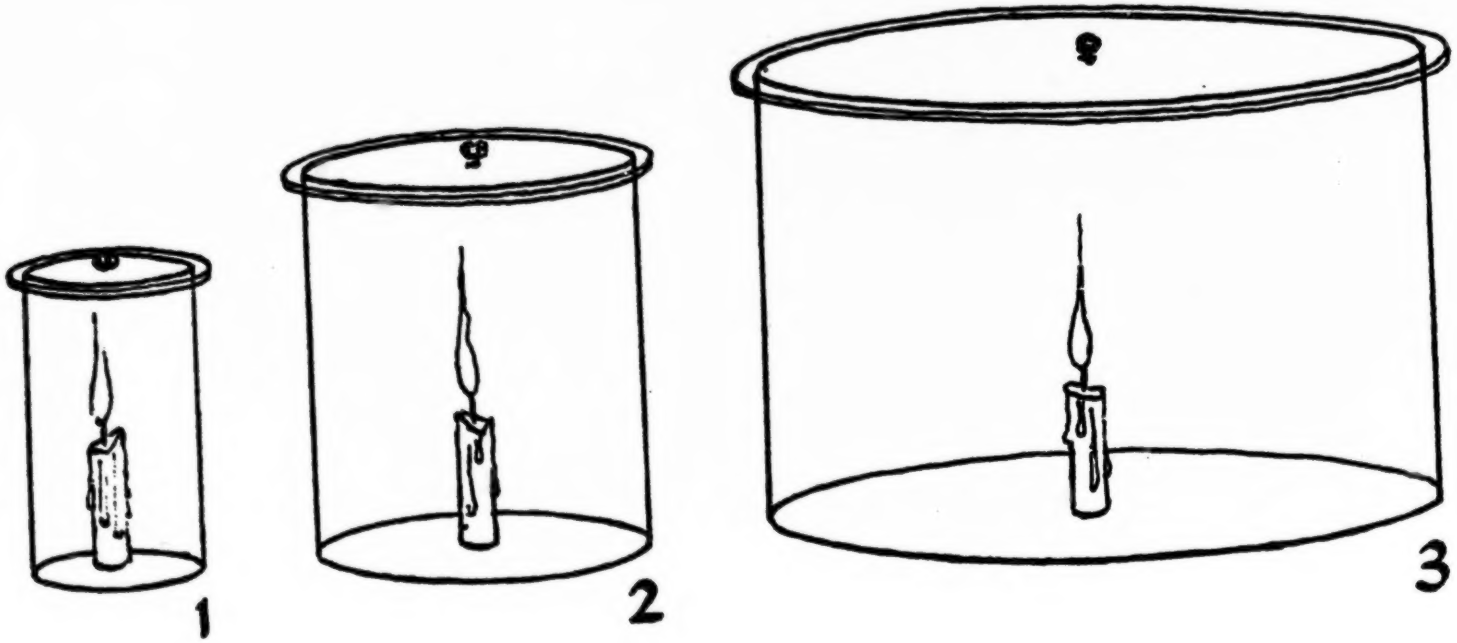
	A	B	C	D	E
1	○	○	○	●	○
2	○	○	○	○	●

You will have forty minutes for the test.

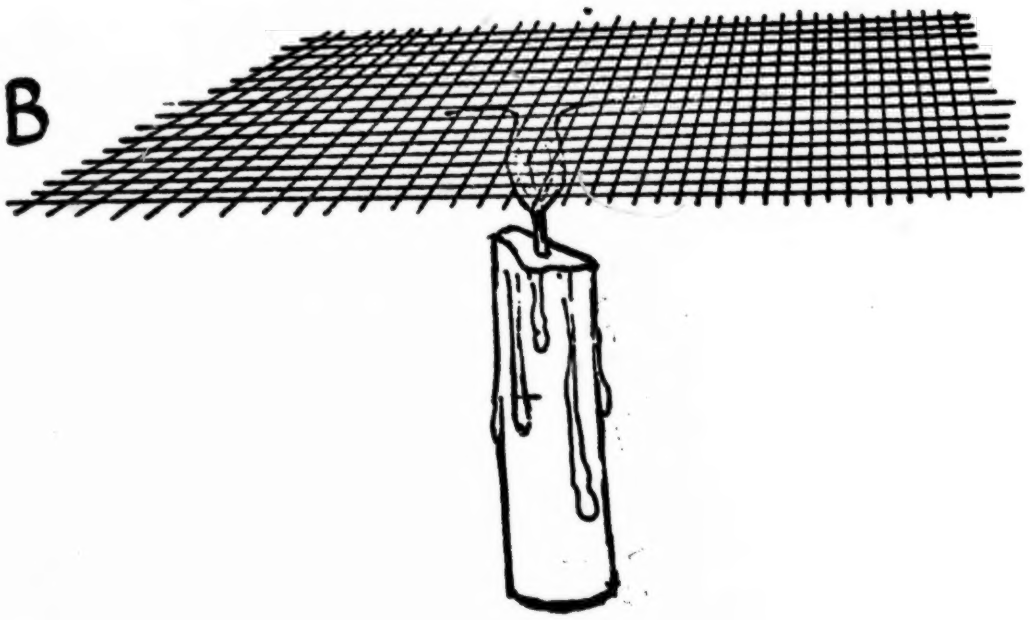
On the answer sheet you will begin marking your answers on the bottom half (TEST TWO), questions one through sixty.

Be sure you mark your answer in the answer row that has the same number as your question.

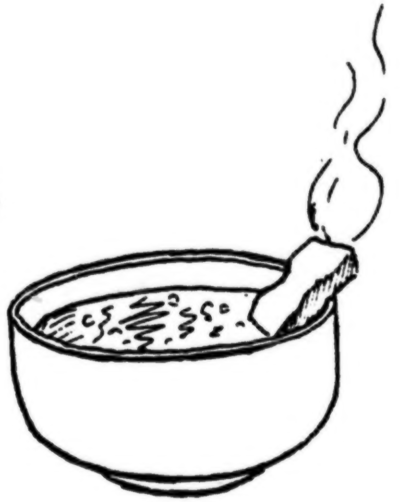
A



B



C



HOW WE FIND OUT
(PROCESS)

1. The candles in the covered jars will go out in which order?

   A. at the same time
   B. 1, 2, 3
   C. 2, 1, 3
   D. 3, 2, 1
   E. 1, 3, 2

3. The copper window screen in (B) stops the flame from going through it because:

   A. air pressure changes above and below the screen
   B. the holes in the screen are too small
   C. there is too little oxygen above the screen
   D. heat is transferred to the copper
   E. the flame is too weak

5. A piece of clay flower pot could be used as a wick for the oil lamp in (C) because it:

   A. doesn't burn
   B. will let oil pass through it
   C. also burns
   D. glows when heated
   E. is hard

WHAT IS KNOWN
(PRODUCT)

2. The candle burns because of the presence of:

   A. carbon dioxide
   B. nitrogen
   C. oxygen
   D. air
   E. chlorine

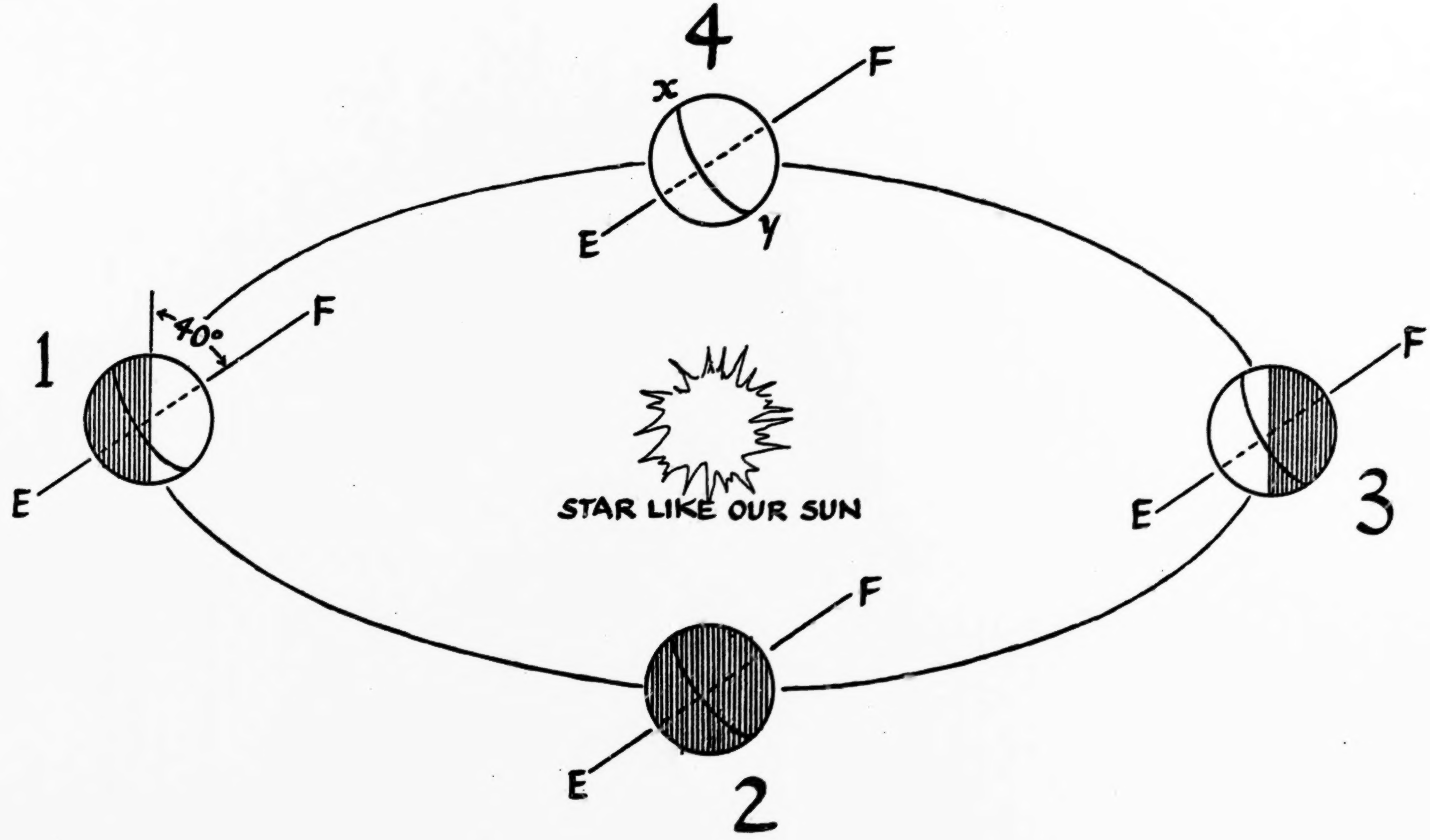
4. Heat and light from candles came first from the:

   A. earth's gravity
   B. earth
   C. paraffin wax
   D. sun
   E. fat of animals

6. Smoke is:

   A. unburned carbon
   B. condensed steam
   C. finely divided ashes
   D. paraffin gas
   E. a mixture of all of the above

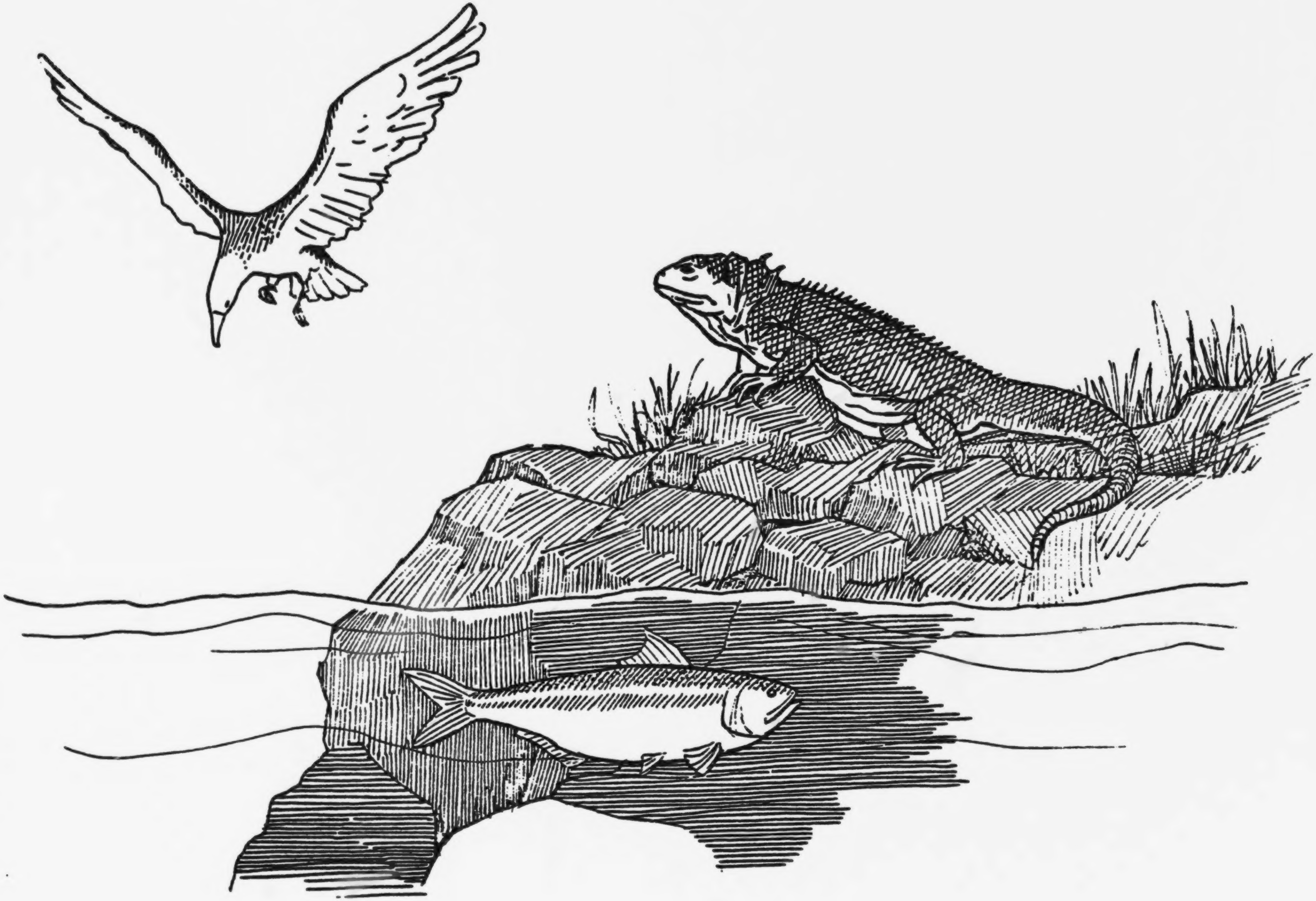
IMAGINARY PLANET "TRID"


4
x
F
E
y
1
40°
F
E
STAR LIKE OUR SUN
3
F
E
2
F
E

The drawing represents one imaginary planet, "Trid," which moves around a "star" like our sun. The orbit of Trid is the same as the earth's. Trid is inhabited by both plant and animal life.

Trid revolves on its axis (E, F) which tilts at an angle of 40° instead of the 23½° tilt of the earth's axis.

HOW WE FIND OUT (PROCESS)	WHAT IS KNOWN (PRODUCT)
7. If Portland were on Trid, our summer would be: A. longer B. hotter C. shorter D. colder E. none of the above	8. In position 4, the solid line XY represents the planet's: A. tropic of cancer B. axis C. meridian D. 45th parallel E. equator
9. In position 1, the "E" hemisphere is having: A. winter B. summer C. fall D. spring E. night	10. Trid travels in an orbit around its "sun" because of: A. its tilt B. rotational attraction C. atmospheric friction D. gravitational attraction E. centrifugal force



HOW WE FIND OUT
(PROCESS)

11. Iguanas move slowly. The fact that they are still living on this island is mainly because they have:

A. enough food
B. few enemies
C. the right temperature
D. tasted bad to other animals
E. not been noticed

13. The shading on the fish in the picture probably means that:

A. enemies follow it
B. enemies live above and below it
C. enemies attack from the front
D. enemies are color blind
E. fish like different colors

15. The bird in the picture is able to fly because it:

A. has a very low ratio of body weight to wing surface area
B. has a wide wing spread
C. can tuck its legs under its body
D. is able to glide
E. all of the above

17. Many fish and birds are darker on top than below. This probably is because:

A. they have pigments in the skin
B. birds fly and fish swim
C. the sun tans them on top
D. they then match the sky and the ground
E. they live in dark and light places

19. The iguana pictured is green in color. It is not likely that it would be found in this environment because:

A. it doesn't catch fish
B. it would be easily noticed
C. rocks aren't big enough to hide it
D. the air would be salty
E. none of the above

WHAT IS KNOWN
(PRODUCT)

12. The use of color, shading, or pattern for protection is called:

A. striping
B. control
C. camouflage
D. dark and light
E. matching

14. The space around these animals is called their:

A. ecology
B. area
C. environment
D. evolution
E. world

16. An animal that can change its color to match its background is the:

A. praying mantis
B. quail
C. cougar
D. chameleon
E. rattlesnake

18. When an animal changes color, pattern, or shading over millions of years, the process is called:

A. adjustment
B. adaptation
C. adhering
D. absorption
E. abrasion

20. Animals change through the years. These changes are the result of:

A. assimilation
B. metabolism
C. necessity
D. evolution
E. diet

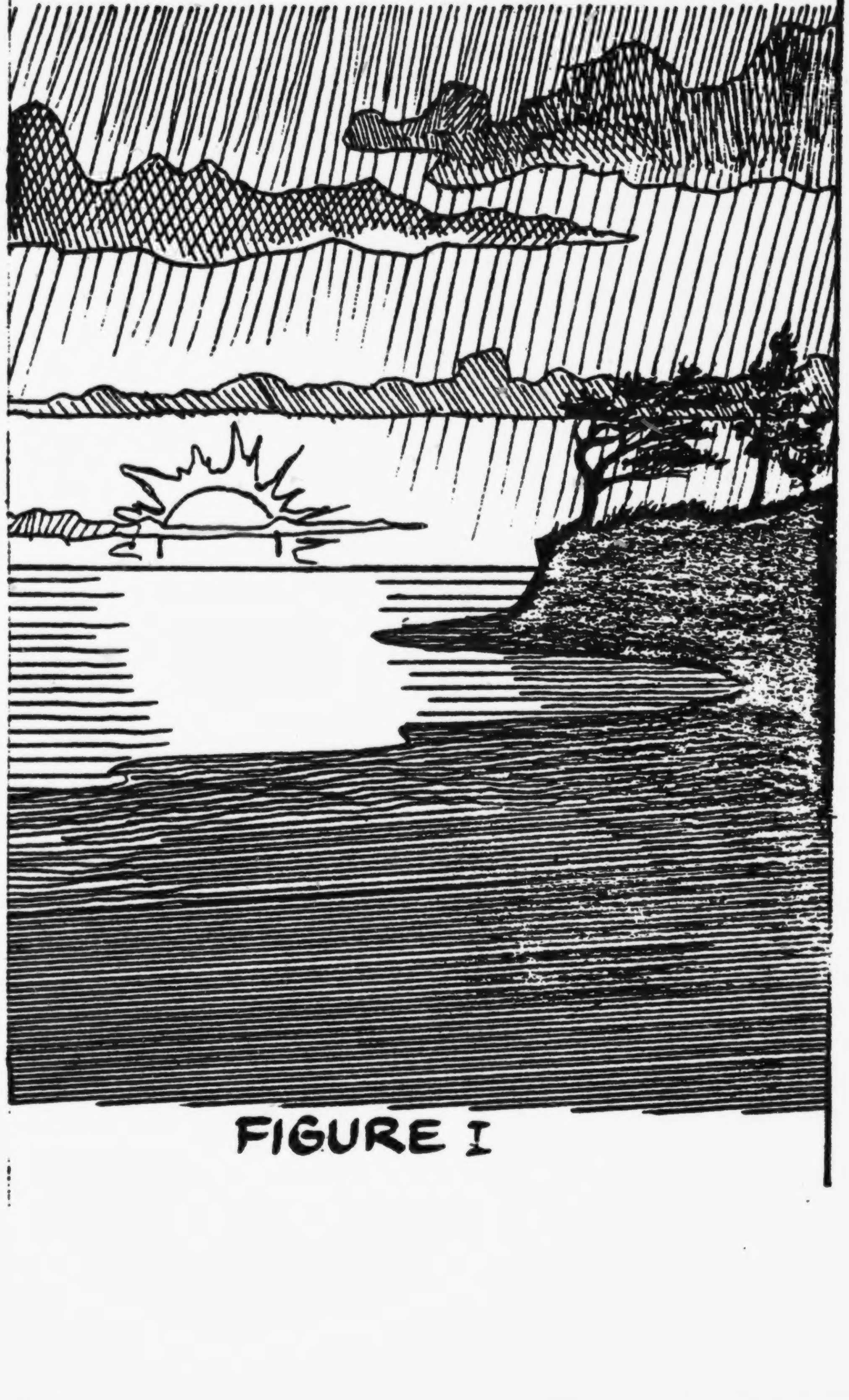


FIGURE I

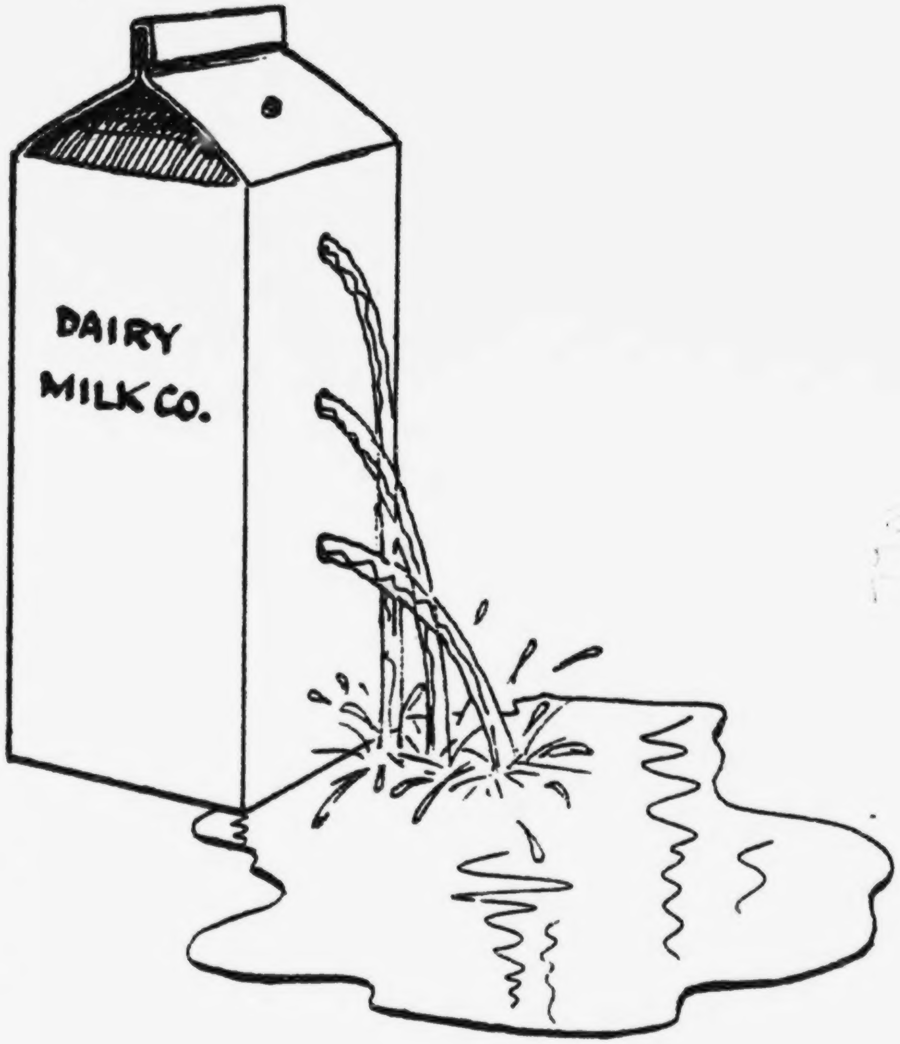

DAIRY
MILK CO.

FIGURE II

FIGURE I

HOW WE FIND OUT (PROCESS)	WHAT IS KNOWN (PRODUCT)
21. A scientist wants to know what the sun is made of. He may learn most about it by studying the sun's: A. movements B. light C. size D. spots E. distance	22. It is reasonable to assume that the sun consists of: A. the same elements present on our earth B. only gases present on our earth C. molten rock D. a liquid core E. elements other than those discovered on our earth
23. Day follows night because the earth: A. reflects light B. is round C. moves around the sun D. spins on its axis E. acts like a magnet	24. A light year measures: A. light B. space C. distance D. speed E. time

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FIGURE II

25. To make all three streams shoot out the same distance you might:

A. make all the holes larger
B. turn the carton upside down
C. place the carton in a cup of water
D. turn the carton on its side
E. shake the carton

26. Pressure means:

A. molecules pull
B. molecules push
C. weight is exerted
D. volume is decreased
E. all of the above

27. The reason for the hole at the top of the carton is to let:

A. you check the level of the water
B. air into the carton
C. water into the carton
D. light into the carton
E. the carton empty fast

28. One way to purify water is to use the process of:

A. distillation
B. contraction
C. expansion
D. electrification
E. conflagration

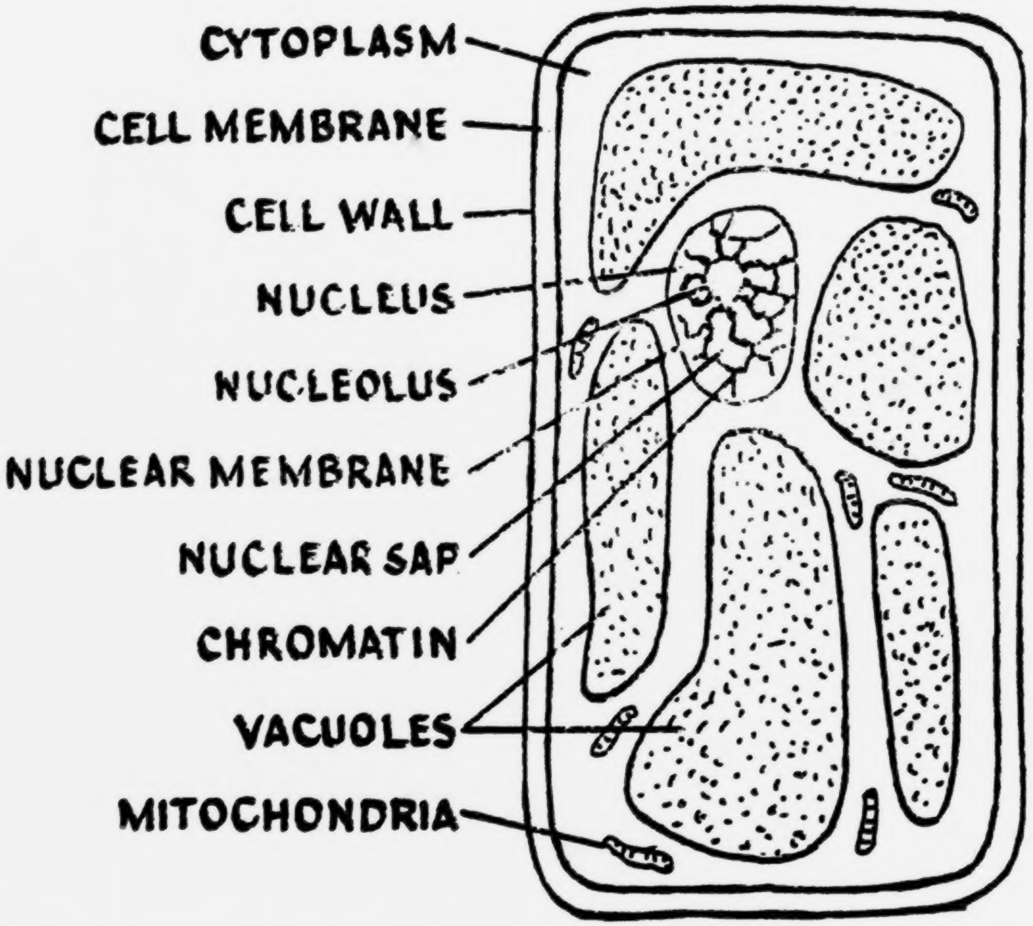
29. The demonstration in Figure II shows that:

A. water moves at different speeds
B. the deeper the water, the greater the water pressure
C. water flows out the holes in the milk carton
D. the deeper the water, the greater the air pressure
E. air pressure causes the water to shoot out

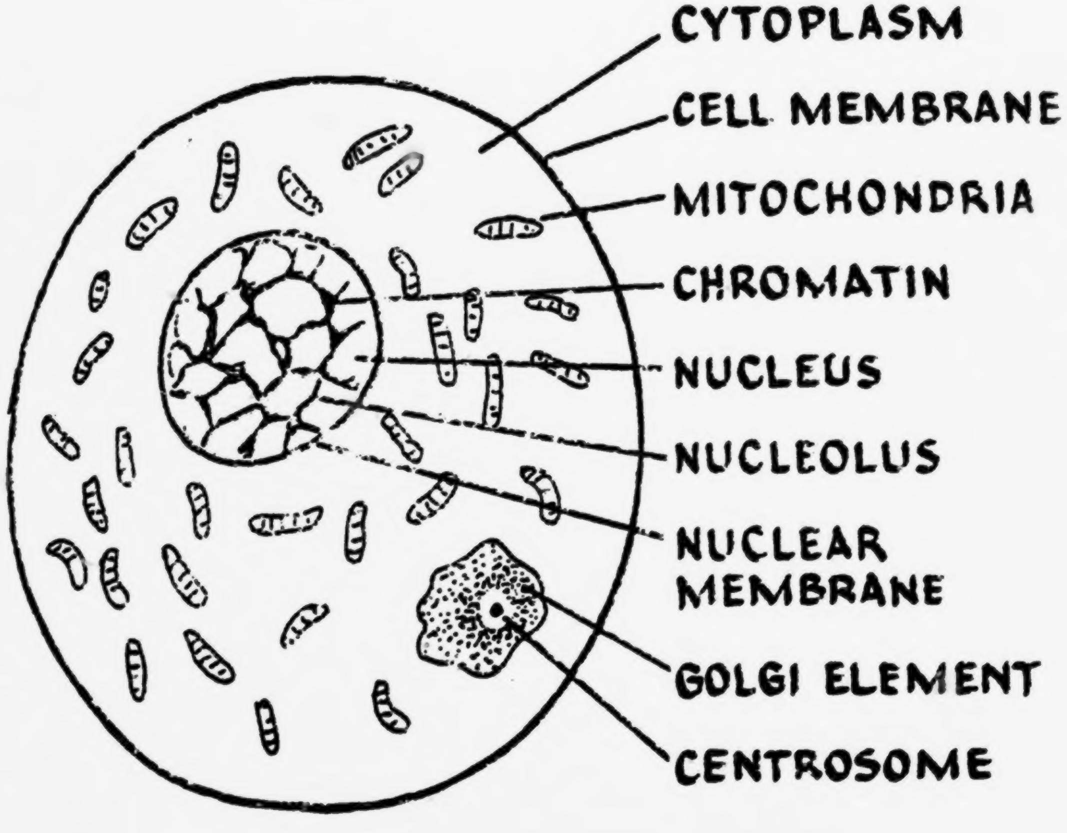
30. Water is made of:

A. two gases chemically combined
B. burned hydrogen gas
C. melted crystals
D. twice as much hydrogen as oxygen
E. all of the above

MODEL OF A PLANT CELL


CYTOPLASM
CELL MEMBRANE
CELL WALL
NUCLEUS
NUCLEOLUS
NUCLEAR MEMBRANE
NUCLEAR SAP
CHROMATIN
VACUOLES
MITOCHONDRIA

MODEL OF AN ANIMAL CELL


CYTOPLASM
CELL MEMBRANE
MITOCHONDRIA
CHROMATIN
NUCLEUS
NUCLEOLUS
NUCLEAR MEMBRANE
GOLGI ELEMENT
CENTROSOME

HOW WE FIND OUT
(PROCESS)

31. In comparing the diagrams of the plant and animal cell you notice that:

    A. they look the same
    B. they have the same structure
    C. they contain different parts
    D. there are parts common to the both of them
    E. there are no similarities

33. The best way to observe the reproduction of cells would be to:

    A. obtain an amoeba and feed it with an eye dropper
    B. observe living cells under a microscope
    C. study scrapings from your tongue
    D. study a cross section of a leaf, carefully observing its structure
    E. make a microscope slide of tissue from a paramecium

35. A scientist experimenting with certain organisms containing chloroplasts found that they could be changed from plants to animals. He probably did which of the following?

    A. applied the proper amount of light
    B. clipped the flagellum
    C. destroyed the nucleus
    D. added chlorophyl to its diet
    E. destroyed the chloroplasts

WHAT IS KNOWN
(PRODUCT)

32. The structure of living things depends on the development of:

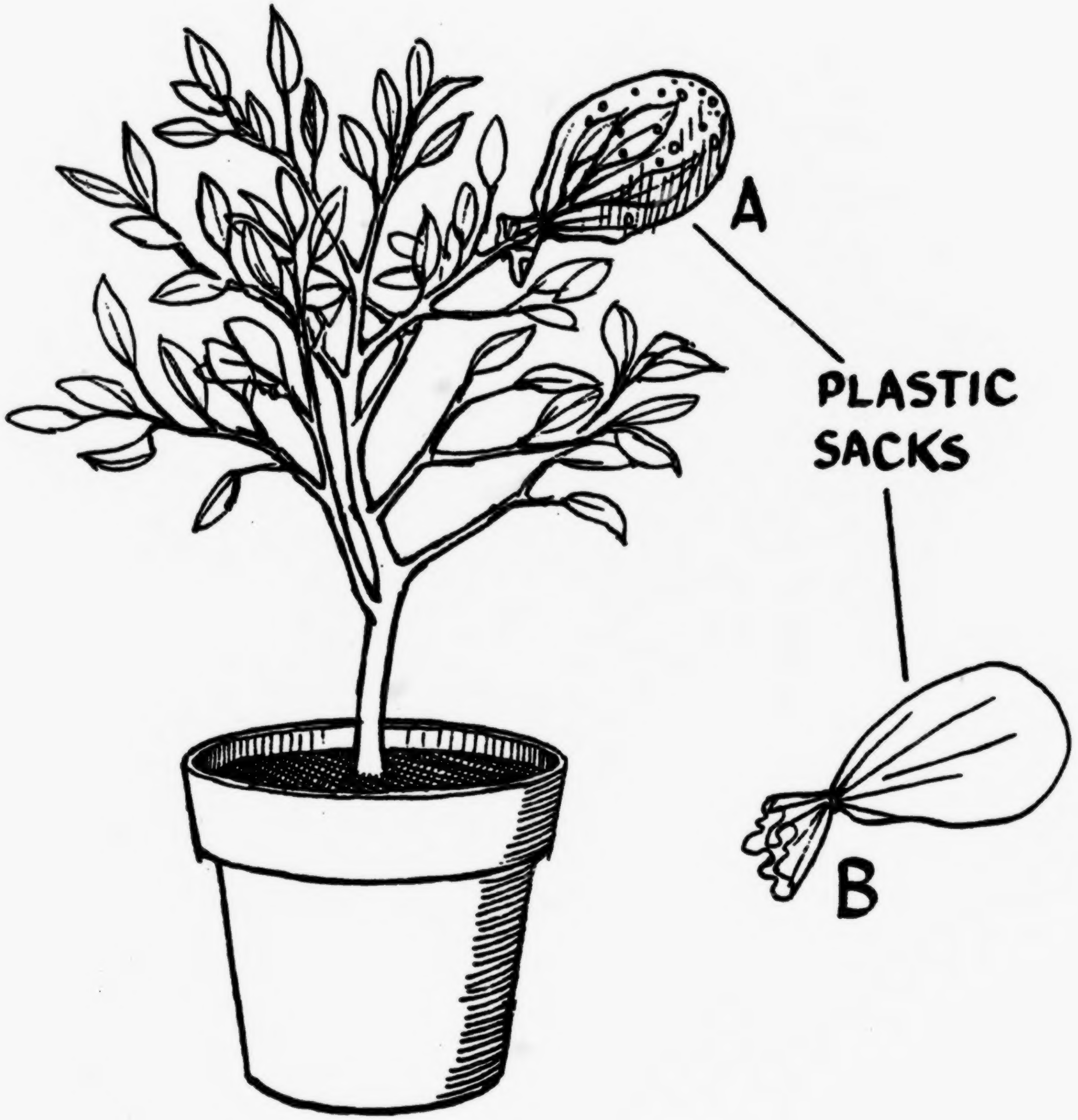
    A. blood
    B. protein
    C. enzymes
    D. bones
    E. cells

34. Which of the following are not common to both the plant and the animal cell?

    A. nucleus
    B. cell wall
    C. cytoplasm
    D. chromatin
    E. nucleolus

36. Which of the following are common to both the plant and the animal cell?

    A. vacuoles
    B. golgi elements
    C. nuclear sap
    D. nucleus
    E. cell wall


A
PLASTIC
SACKS
B

HOW WE FIND OUT
(PROCESS)

37. Plastic sack (A) has drops of water in it. (B) has none. The water in sack (A) comes from the:

A. plastic
B. air
C. lack of air current
D. leaf
E. carbon dioxide gas

39. To show that a plant takes water from the soil you could:

A. add colored water to the soil
B. put colored water on the leaves
C. measure the water in the leaves
D. weigh the water in the leaves
E. crush the plant and measure the water

41. The best way to measure the water given off by the plant is to:

A. feel the leaves
B. weigh the dirt after watering
C. weigh the dirt before watering
D. weigh the water added in watering
E. weigh the water collected in the plastic sack

WHAT IS KNOWN
(PRODUCT)

38. Water vapor becomes liquid when it is:

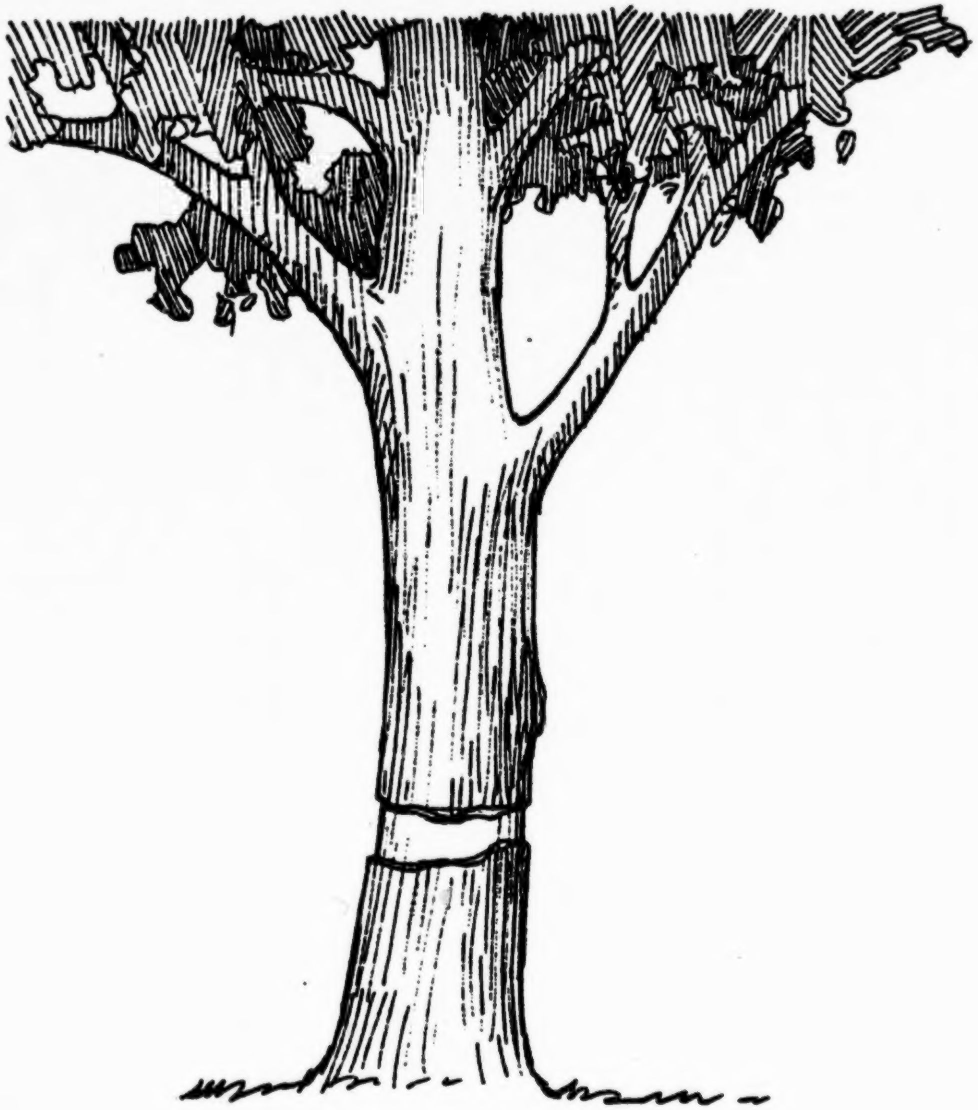
A. darkened
B. lighted
C. cooled
D. heated
E. dried

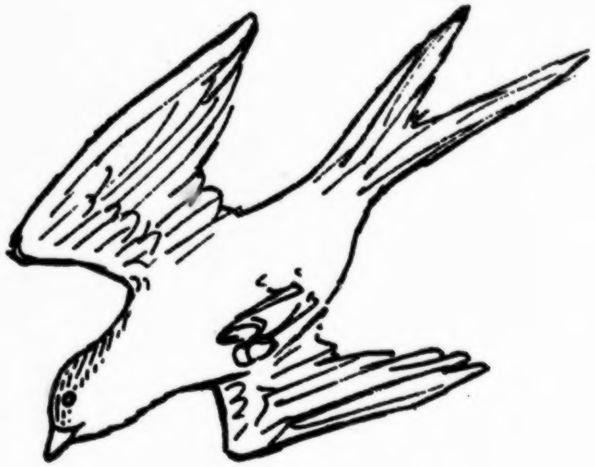
40. What process is not shown in plastic sack (A)?

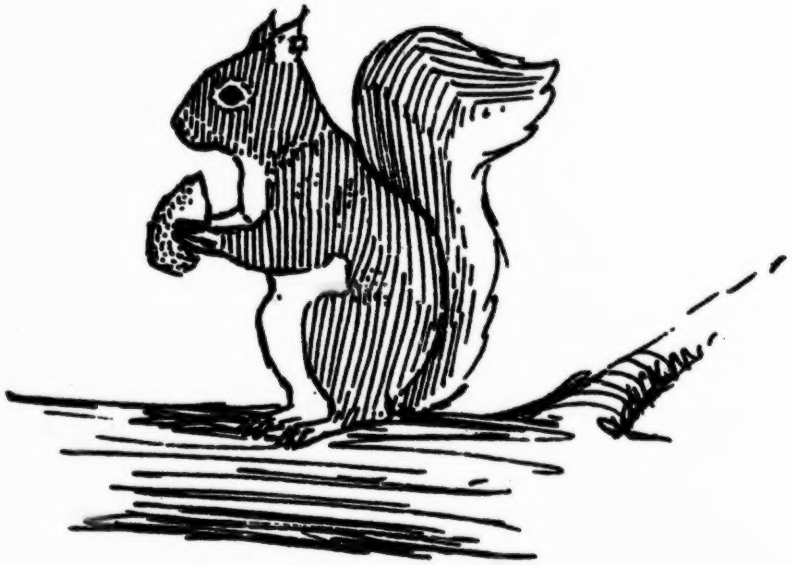
A. osmotic pressure
B. transpiration
C. photosynthesis
D. evaporation
E. condensation

42. Water in a plant moves:

A. from leaf, to stem, to roots
B. from roots, to stem, to leaf
C. through leaves only
D. through roots only
E. through stem only







HOW WE FIND OUT
(PROCESS)

43. A scientist placed identification tags on the squirrels in the park. He was trying to find out if they:

A. were decreasing in numbers
B. were increasing in numbers
C. hibernated at different times
D. left the area
E. all of the above

45. In an experiment the squirrel was kept in surroundings at a temperature near freezing for six months. The scientist probably was trying to determine the squirrel's:

A. gestation period
B. basic metabolic rate
C. temperature effects
D. social behavior
E. all of the above

47. Green plants were placed in a dark room. They died because:

A. they couldn't breathe
B. they couldn't make food
C. the dirt became spoiled
D. they didn't have enough water
E. they were not used to the dark

49. A boy cut a ring through the bark around the trunk of a tree. It is very likely the tree will die because:

A. the tree lacks water and minerals
B. disease germs entered the cut
C. air dried it out
D. there wasn't enough rain
E. the roots will die because they can't get food

WHAT IS KNOWN
(PRODUCT)

44. An animal scientist (zoologist) divides animals into groups by studying their:

A. location
B. habits
C. size
D. structure
E. movement

46. The population of a species is restricted by:

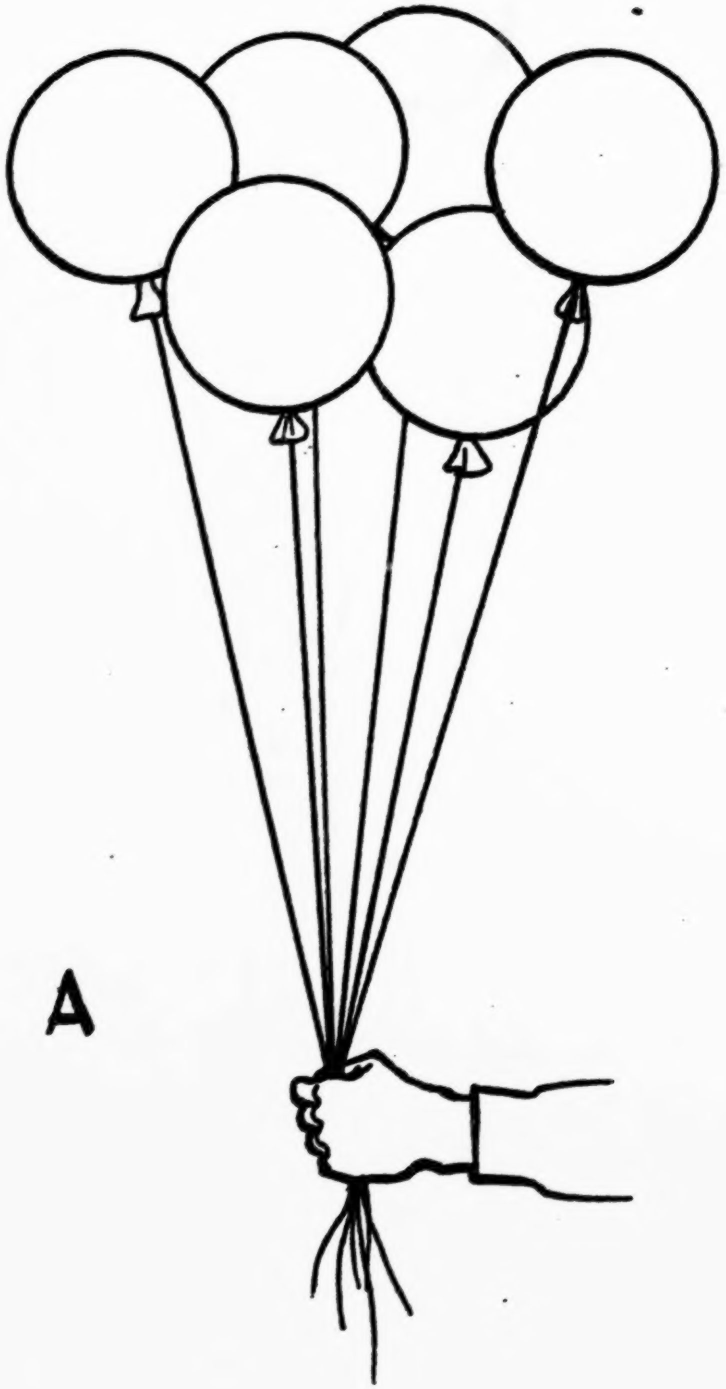
A. predators
B. the food supply
C. climate
D. its own rate of reproduction
E. all of the above

48. Chlorophyll in plants helps them to:

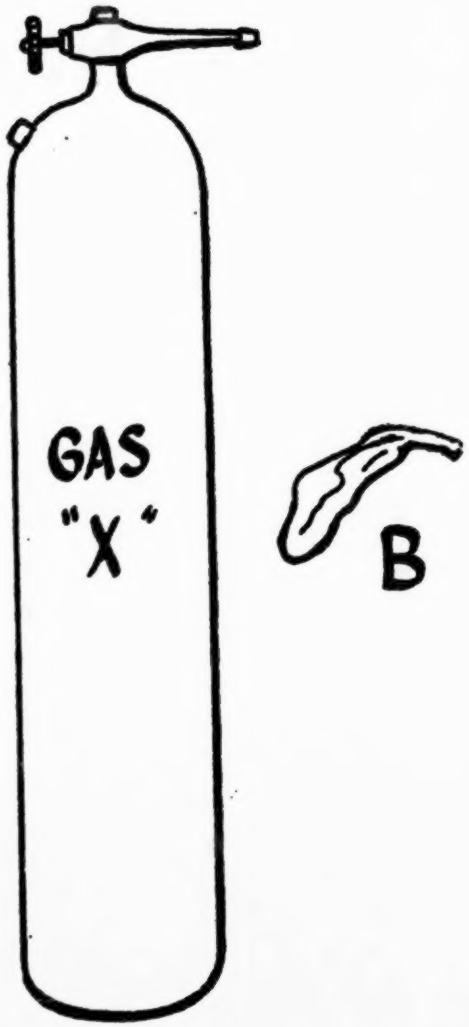
A. make food
B. breathe
C. hold water
D. produce seeds
E. move about

50. The water present in green plants is important as a:

A. reservoir
B. way to keep them upright
C. material for making sugar
D. solvent
E. all of the above



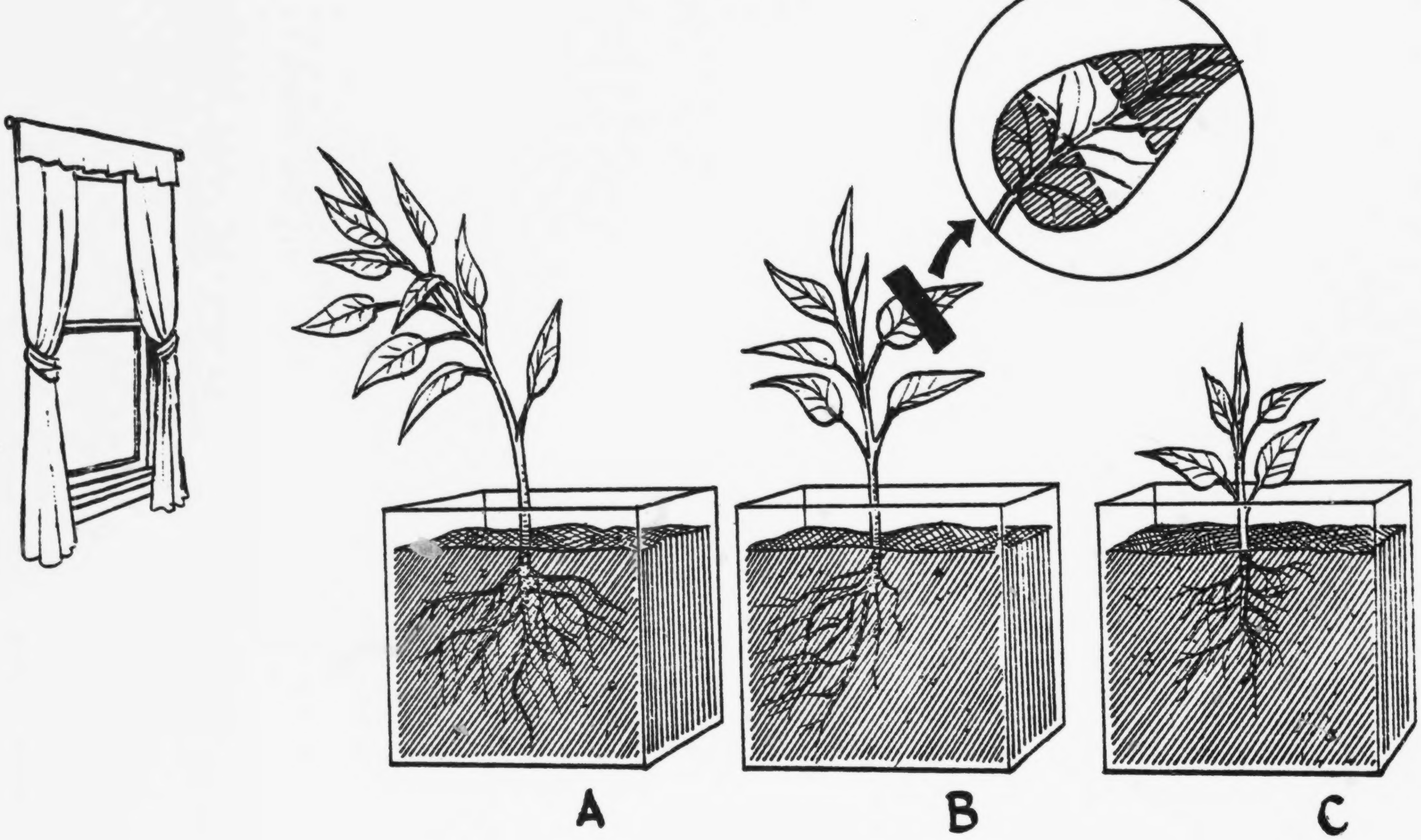
A



B

HOW WE FIND OUT (PROCESS)	WHAT IS KNOWN (PRODUCT)
51. You fill the balloon (B) with gas "X". The balloon rises. This shows that gas "X": A. is lighter than air B. has less pressure than air C. is heavier than air D. has more pressure than air E. is colder than the air around it	52. The balloons (A) are up in the air because: A. the gas inside is lighter than the gas outside B. the strings are nylon C. the warm sun made them rise to where they are D. the balloons are filled with carbon dioxide E. all gases are lighter than air
53. You could make the balloons get larger by placing them: A. on a mountain peak B. below sea level C. in a refrigerator D. in front of a fan E. under water	54. When a balloon gets larger the gas molecules in it are: A. farther apart B. closer together C. getting out through the balloon D. changing their form E. getting larger

27v


A
B
C

HOW WE FIND OUT
(PROCESS)

55. A possible reason for the roots in (B) growing to the left could be:

A. the black paper on the leaf
B. the sunlight came only from the left
C. poor soil conditions on the right
D. over fertilization on the left
E. water is only on the left

57. An important advantage that green plants have over animals is that they:

A. move about more
B. can smell food
C. make their own food
D. grow faster
E. breathe oxygen

59. One part of a leaf from plant (B) was covered with black paper for a week. At the end of the week that part of the leaf was pale. This probably was because the leaf did not get:

A. carbon dioxide
B. oxygen
C. light
D. minerals
E. water

WHAT IS KNOWN
(PRODUCT)

56. The roots of these plants help hold the soil. This prevents:

A. explosion
B. washing
C. erosion
D. plowing
E. soil formation

58. Roots grow down because:

A. leaves grow up
B. plants are straight
C. minerals are in the soil
D. sunlight will injure them
E. they are positively geotropic

60. Plants bend toward light. This is called:

A. solar movement
B. photography
C. phototropism
D. flowering
E. twisting

TF 13 Science

MAJOR CONCLUSIONS IDENTIFIED BY PROJECT STAFF

TF 13- 1. Elementary teachers and administrators are not aware of the goals of a modern science program. They need to understand the role which science and its mode of inquiry play in daily living.

TF 13- 2. The elementary science curriculum should reflect the dynamic nature of change which exists throughout society.

TF 13 3. Science coordinators are needed in each building.

TF 13- 4. It is not necessary that the elementary science curriculum follow the sequence of a text.

TF 13- 5. The elementary science program should follow the guidelines given in The Science Framework for California Public Schools, 1968 and utilize such materials as Science, a Process Approach and the Science Curriculum Improvement Study.

TF 13- 6. The junior high school program should be extended to grades 7 and 9. The one year course covering all areas of science is not adequate.

TF 13- 7. The junior high science program should be laboratory oriented not directed to the products of science.

TF 13- 8. The science teaching staff needs to be increased,perhaps with auxillary personnel (lab assistants, teacher aides, interns, etc.).

TF 13- 9. Larger classrooms facilities, and equipment are needed to teach science when laboratory centered teaching methods are used.

TF 13- 10. The physical science program in the senior high should be studied with the thought of correcting the imbalance of physical-biological science offerings.

TF 13- 11. A need exists for a physical science course at the senior high level that has practical value and helps student better understand their physical environment.

TF 13- 12. There is a need for in-service training programs for elementary teachers designed to develop a mode of scientific inquiry and skills for investigating.

TF 13- 13. Advanced biology, physiology, and zoology should be given *in addition to* rather than *instead of* courses in the physical sciences.

TF 13- 14. There is a need for parent education related to the modern science program.

TF 13- 15. There is a need for more community support for the schools.

TF 13- 16. More readable science materials are need in the disadvantaged areas.

TF 13- 17. There is a need to emphasize the use and function of the scientific method in all phases of the instructional program.